VOLUME XXXV NUMBER FIVE

THE NATIONAL GEOGRAPHIC MAGAZINE

MAY, 1919

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ORGANIZED FOR "THE INCREASE AND DIFFUSION OF GEOGRAPHIC KNOWLEDGE"

To carry out the purpose for which it was founded thirty-one years ago, the National Geographic Society publishes this Magazine. All receipts from the publication are invested in the Magazine itself or expended directly to promote geographic knowledge and the study of geography. Articles or photographs from members of the Society, or other friends, are desired. For material that the Magazine can use, generous remuneration is made. Contributions should be accompanied by an addressed return envelope and postage, and be addressed: Editor, National Geographic Magazine, 16th and M Streets, Washington, D. C.

Important contributions to geographic science are constantly being made through expeditions financed by funds set aside from the Society's income. For example, immediately after the terrific eruption of the world's largest crater, Mt. Katmai, in Alaska, a National Geographic Society expedition was sent to make observations of this remarkable phenomenon. So important was the completion of this work considered that four expeditions have followed and the extraordinary scientific data resultant given to the world. In this vicinity an eighth wonder of the world was discovered and explored—"The Valley of Ten Thousand Smokes," a vast area of steaming, spouting fissures, evidently formed by nature as a huge safety-valve for erupting Katmai. By proclamation of the President of the United States, this area has been created a National Monument. The Society organized and supported a large party, which made a three-year study of Alaskan glacial fields, the most remarkable in existence. At an expense of over $50,000 it has sent a notable series of expeditions into Peru to investigate the traces of the Inca race. The discoveries of these expeditions form a large share of the world's knowledge of a civilization which was waning when Pizarro first set foot in Peru. Trained geologists were sent to Mt. Pelee, La Soufriere, and Messina following the eruptions and earthquakes. The Society also had the honor of subscribing a substantial sum to the historic expedition of Admiral Peary, who discovered the North Pole April 6, 1909. Not long ago the Society granted $20,000 to the Federal Government when the congressional appropriation for the purchase was insufficient, and the finest of the giant sequoia trees of California were thereby saved for the American people and incorporated into a National Park.

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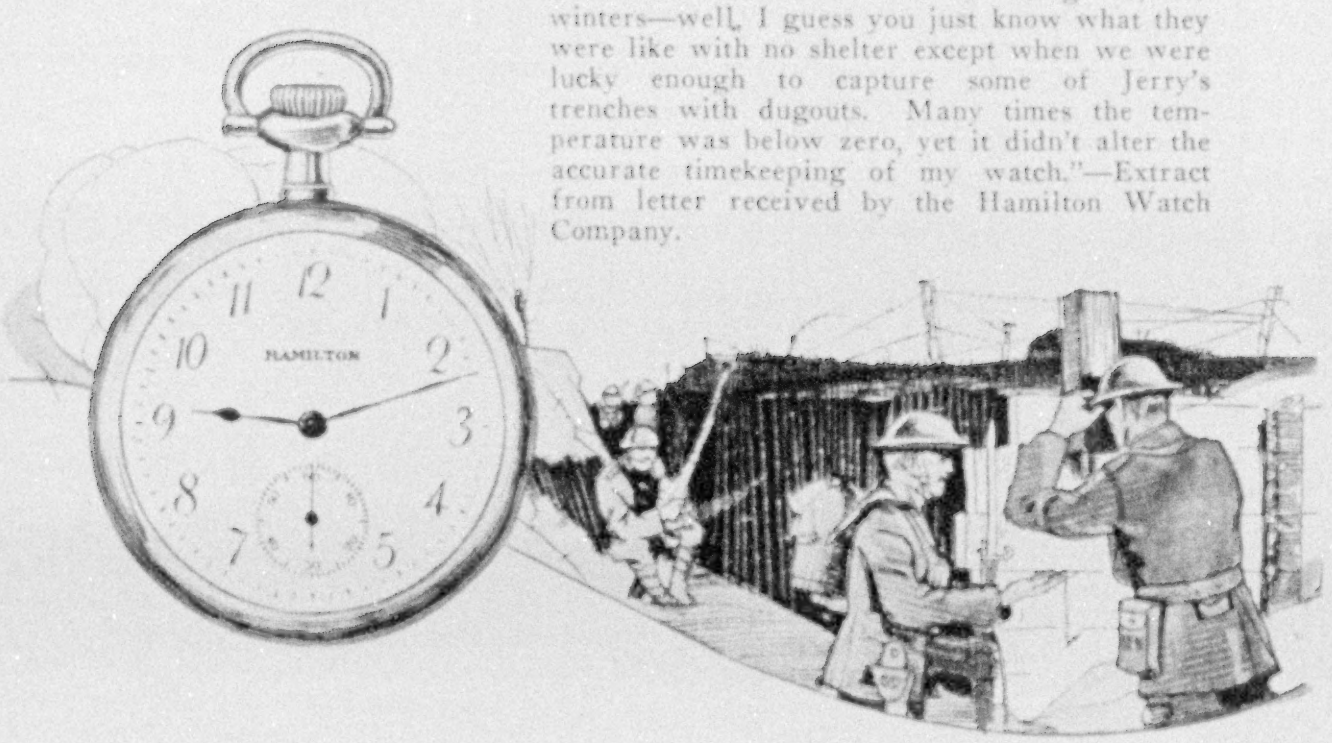
Kept accurate time during Four years in the trenches

"I went to England at the beginning of the War, enlisted in the British Army and served in France for four years with the First Bn., Royal Warwickshire Regiment.

"I carried a Hamilton Watch continuously for the whole four years in rain, mud, ice, snow. In Summer the weather was scorching hot; and winters—well, I guess you just know what they were like with no shelter except when we were lucky enough to capture some of Jerry's trenches with dugouts. Many times the temperature was below zero, yet it didn't alter the accurate timekeeping of my watch."—Extract from letter received by the Hamilton Watch Company.



Hamilton Watch

"The Railroad Timekeeper of America"

THE finer accuracy and greater precision of the Hamilton Watch is a source of pride to the American Watch-making Profession—for this is a purely American Watch, made by American Artisans, by American Watch-making methods.

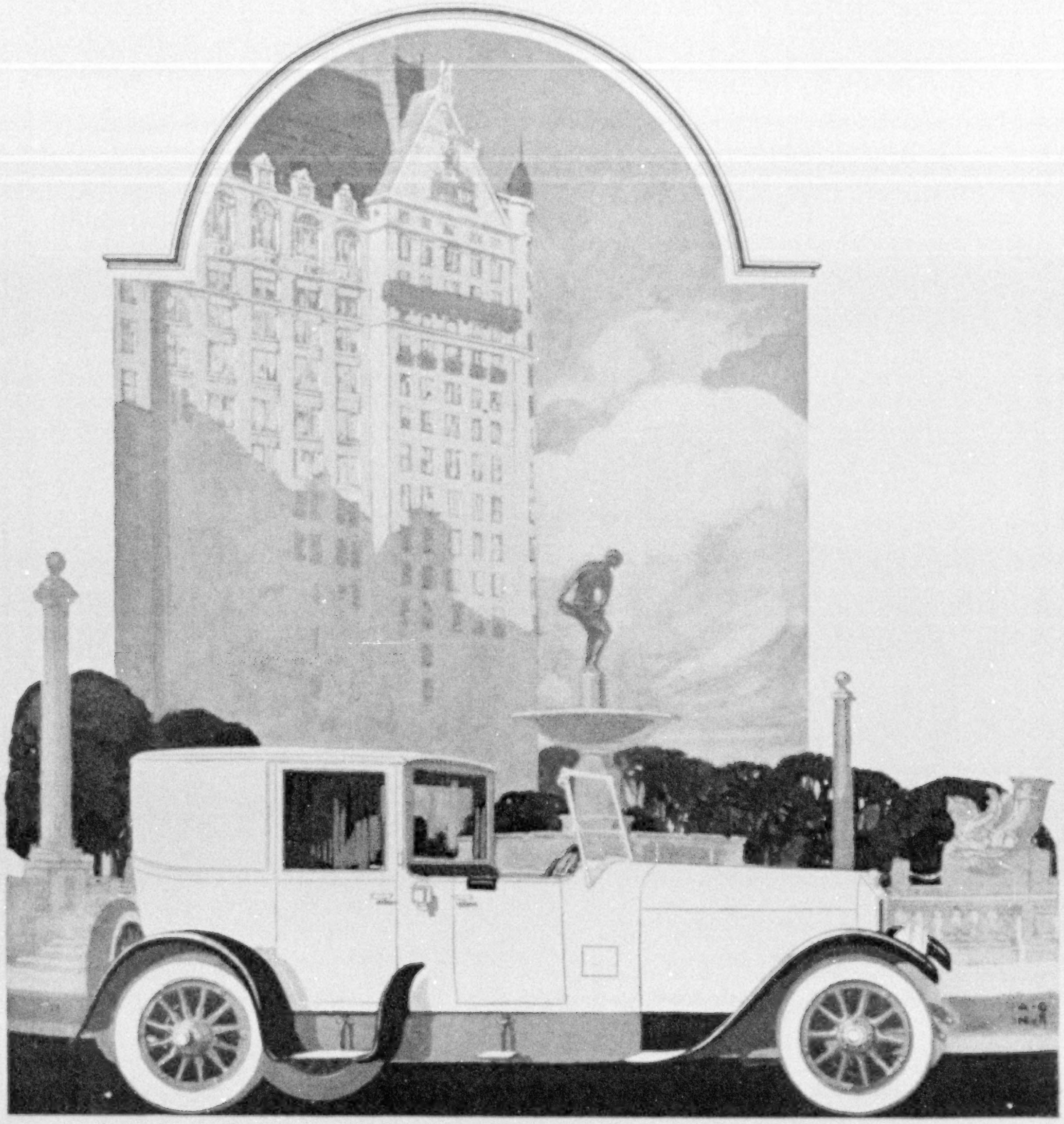
The Hamilton Watch times the greater majority of the fast trains in America as well as the American-built railroads of France.

Whether you want a fine, thin, 12-size watch or a Railroad Model—you will find among the twenty-two Hamilton models exactly the watch you want to own. Not only in beauty of finish, and character of design—but in the accuracy and precision that make the Hamilton the most sought-after watch in the world today.

Full assortments at your jeweler's, ranging from $34 to $170.
Hamilton Movements alone, $18 ($19.50 in Canada), and up.

Send today for "The Timekeeper," which tells the story of the Hamilton, and shows the various models with prices.

HAMILTON WATCH COMPANY, DEPT. 35, LANCASTER, PA.



THE PLAZA BROUGHAM

The Portfolio of Illustrations depicting new designs in
THOMPSON CUSTOM-BUILT BODIES
will prove helpful to those contemplating the purchase of individually designed Coach Work. It will be sent on request.

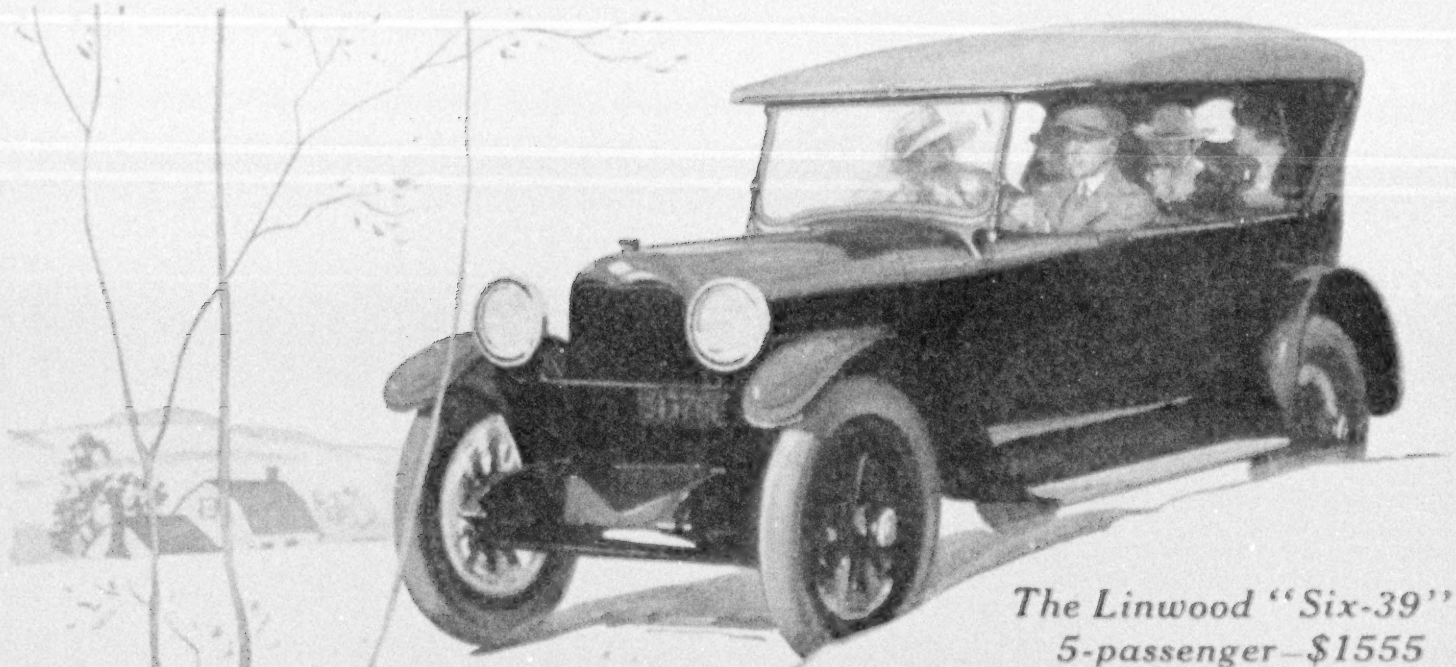
BY Thompson methods, such freedom is permitted in the selection of fittings, arrangement, color, and distinguishing lines, that the body becomes a personal expression of the owner's individuality.

The specialized experience of our designers and skilled artisans insures the mechanical perfection of every Thompson Custom Body.

E. J. THOMPSON CO. **MOTOR CAR BODIES**

Forbes Field, Pittsburgh, Pa. 1765 Broadway, New York

"Mention The Geographic—It identifies you"



The Linwood "Six-39"
5-passenger—$1555
"f. o. b. Detroit"

PAIGE

The Most Beautiful Car in America

In every section of the nation you will find that Paige cars are regarded with respect and confidence. They possess that rare faculty of "making friends": and this, after all, is the final test of any manufactured product.

But Paige popularity, please remember, is not mere *price* popularity. We have never produced a cheap car—and never shall. We believe that freedom from repair bills and excessive depreciation is infinitely more desirable than a mere "catch-penny" list price. So we use only the best of materials and workmanship—regardless of cost. We willingly pay the price of true economy.

In brief, we build enduring satisfaction into every motor car that leaves this plant. We take the necessary time and pains to see that each individual car is worthy of ourselves and our owners—or it cannot bear the Paige name-plate. We build in the one way that we know how to build—for Quality, first, last and all the time.

Such a policy may not be spectacular—but it is sound. It produces motor cars that will outlive any guarantee that we might write for them. It protects and fosters that great volume of good will which is the most valuable asset of this company.

PAIGE-DETROIT MOTOR CAR CO., DETROIT, MICHIGAN

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On the Pipestone Trail, near Lake Louise

An Invitation to Canada

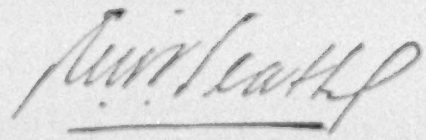
Under the stress of War, the Allies have learned many things, chief of which is that they have a common purpose, common ideals and a common humanity. War has made them better acquainted.

In the days of Peace this better acquaintance should continue, particularly between such near and good neighbors as Canada and the United States. It is for this reason that Canadians wish to emphasize that if any Americans decide to visit Canada this summer, they will be more welcome even than in the past.

They will find a country of unique grandeur and beauty if they come, for instance, to the Canadian Rockies. They will travel in Canada over a railway, the service of which has not been impaired by War, to hotels of which the Canadian Pacific is justly proud. They will, moreover, find a standard of comfort which the experienced traveller appreciates.

But, most of all, Canadians desire Americans to know that they wish to get still better acquainted. They like to visit your country and would like you to come and see theirs.

In spite of the War the Canadian Pacific Railway has maintained its organization of offices and agencies in the United States and these are at your service for information and particulars.



President
CANADIAN PACIFIC RAILWAY

STREAL *Easter*, 1919

CANADIAN PACIFIC RAILWAY

Passenger Offices and Agencies in the United States:

Atlanta, Ga.	220 Healey Bldg	Detroit, Mich	199 Griswold St.	Portland, Ore.	55 Third St.
Boston, Mass.	332 Washington St	Los Angeles, Cal.	605 South Spring St.	St. Louis, Mo.	418 Locust St.
Buffalo, N. Y.	11 So. Division St	Minneapolis, Minn.	611 Second Ave., So.	St. Paul, Minn.	379 Robert St.
Chicago, Ill.	140 South Clark St.	New York, N. Y.	1231 Broadway	San Francisco, Cal.	645 Market St.
Cincinnati, O.	430 Walnut St.	Philadelphia, Pa.	629 Chestnut St.	Seattle, Wash.	608 Second Ave.
Cleveland, O.	2033 East Ninth St.	Pittsburgh, Pa.	340 Sixth Ave.	Tacoma, Wash.	1113 Pacific Ave.
				Washington, D. C.	1419 New York Av.

"The Boy That Night Ate the Last Puffed Grain"

At a house where I visited the hostess said to the writer, "We love Puffed Grains in our home, but somehow we don't use a large amount."

"Let us see why," I suggested.

Next morning she served Puffed Rice for breakfast, and the last grain was consumed. At noon she served Puffed Wheat in milk, and not a kernel left the table.

In the afternoon the daughter used two cups of Puffed Rice in candy. And the boy that night at bedtime ate the last Puffed Grain in the house.

That's All the Trouble

You will find that children eat all the Puffed Grains they get. The only limit when you serve them is the bottom of the dish.

These are airy, toasted bubbles, thin and flaky, puffed to eight times normal size. In form and flavor Puffed Grains are exquisite.

They are whole-grain foods—Puffed Wheat and Puffed Rice. And children need whole grains.

They are steam exploded, shot from guns. By this unique process of Prof. Anderson every food cell is blasted. Thus digestion is easy and complete. No other process ever known so fits grain foods to digest.

Don't you think it a vast mistake when such foods are served sparingly, and lesser foods take their place?

Puffed Wheat Puffed Rice
And Corn Puffs

All Bubble Grains—Each 15c *Except in Far West*

The Quaker Oats Company

Sole Makers

(3063)

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Titles of Booklets

WESTERN

Rocky Mountain Nat'l Park, Colo.

Yellowstone Nat'l Park, Wyo.

Glacier Nat'l Park, Mont.

Grand Canyon Nat'l Park, Ariz.

Mount Rainier Nat'l Park, Wash.

Crater Lake Nat'l Park, Ore.

Yosemite Nat'l Park, Calif.

Sequoia and General Grant Nat'l Parks, Calif.

Hawaii Nat'l Park, Hawaii

Mesa Verde Nat'l Park, Colo.

Hot Springs Nat'l Park, Ark.

Zion National Monument, Utah.

Petrified Forest Nat'l Monument, Ariz.

Colorado and Utah Rockies

California for the Tourist

Pacific North West and Alaska

Arizona and New Mexico Rockies

CENTRAL

Northern Lakes (Wisconsin, Minnesota, Iowa, Illinois and Upper Michigan)

Michigan (Lower Peninsula)

EASTERN

New England Lakes and Mountains

New England Shores north and east of Boston

New England Shores south of Boston

New Jersey Seashore

Adirondacks and Thousand Islands

Saratoga Springs, Lake George, and Lake Champlain

Niagara Falls and Highlands of Ontario

Catskill Mountains and Sullivan County, N. Y.

The Poconos, Delaware Water Gap, Mauch Chunk, and Chatauqua Lake

Long Island, N. Y.

Blue Ridge and Alleghany Mountains

Summer Resorts in the South

Your Vacation Trip

Plan It Now

Let These Free Booklets Guide You.

To the National Parks, to the seashore or the lakes; to the mountains, the woods or places of historic interest.

Make this a summer of Vacation Travel. The transportation facilities of the Nation are again at your service for pleasure trips.

North, South, East and West, in every section, glorious out-of-door playgrounds beckon you. Heed the call. Get away. See unfamiliar places. Know the scenic beauties and grandeur of your land.

Every American owes himself a visit to our National Parks—a vast region of peaks, canyons, glaciers, geysers, big trees, volcanoes, prehistoric ruins, and other wonders.

Visit the seashore, the lakes, the mountains, the woods, and the many places of historic charm. Choose the seclusion of the camp or the enjoyment of social life at the great resorts.

Money and time spent in a well-planned vacation is a health investment. Its returns are big in renewed energy and the joy of living.

Summer Excursion Fares

to National Parks and Principal Resort Regions

Printed on this page is a list of booklets, covering summer-time attractions. Note the different titles. Decide which you want.

Each booklet is attractively illustrated and contains up-to-date, authoritative information. These booklets will help you decide where to go. They are furnished free.

Ask your local ticket agent to help you plan your trip—or apply to the nearest Consolidated Ticket Office—or mail the coupon below to the nearest Travel Bureau.

DIRECTOR GENERAL OF RAILROADS 1918

·UNITED·STATES·RAILROAD·ADMINISTRATION·

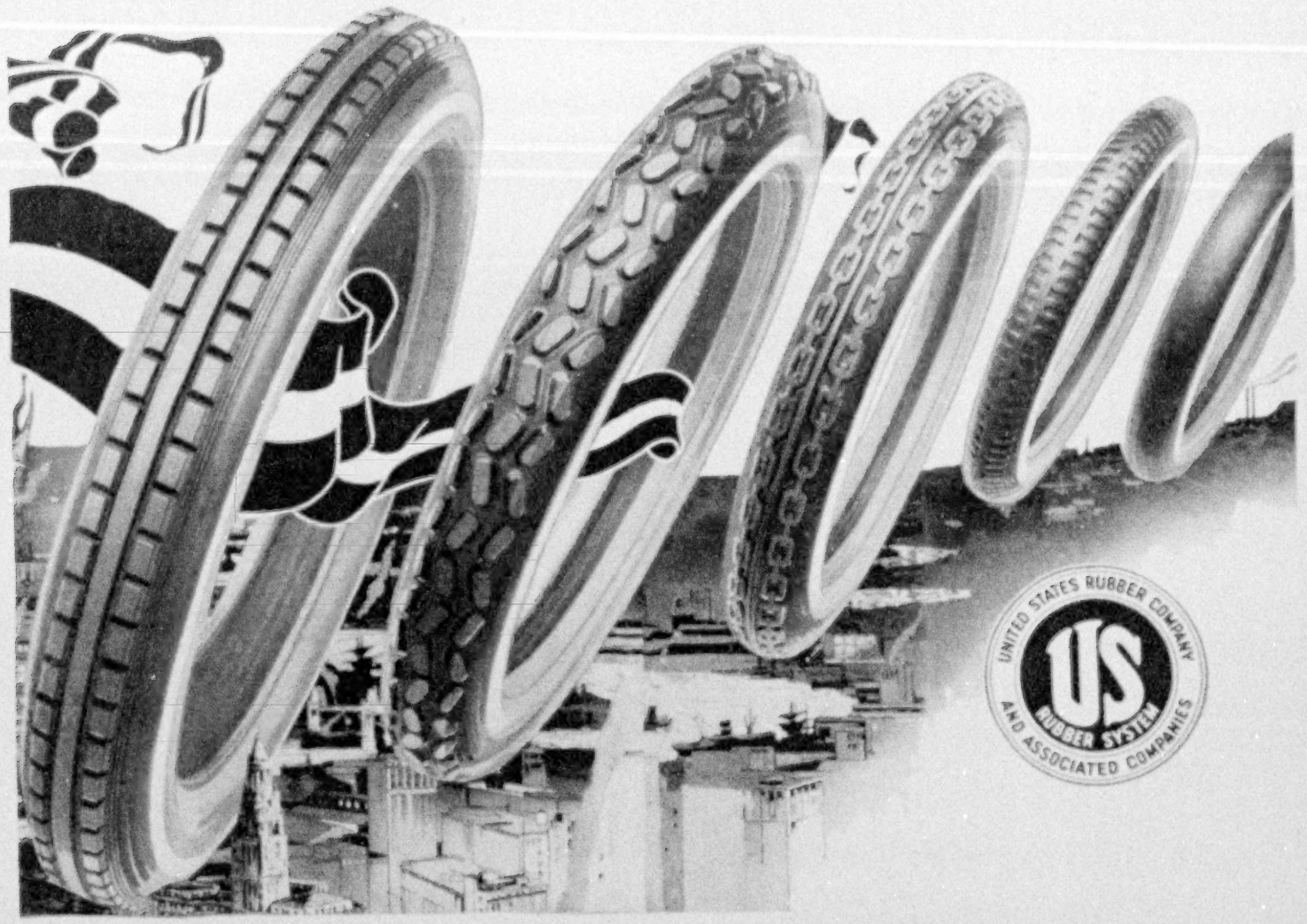
Travel Bureau	Travel Bureau	Travel Bureau
143 Liberty Street	646 Transportation Building	602 Healey Building
New York City	Chicago	Atlanta

Mail this coupon to the nearest Travel Bureau for Free Booklets of the section you plan to visit

Please mail me booklets as follows:

Name _____ Street Address _____

City _____ State _____



Your Car–Your Roads and Your Tires

There are two factors which determine the best tires for your use. One is your car. The other, the roads your car travels.

With these two points clearly in mind, any United States Tire Sales and Service Depot Dealer can provide you with tires that will give you the long, uninterrupted service you want and should have.

Experience has taught us that nc one tire will meet all the varying conditions faced by American motorists.

That's why we build *five distinct types* of United States Tires—'Royal Cord', 'Nobby', 'Chain', 'Usco' and 'Plain'. A tire for every need of price or use. In this way, we make it possible for every American motorist to have good tires that will meet his individual requirements to perfection.

Look up our nearest Sales and Service Depot Dealer. He will tell you which United States Tires are exactly suited to your needs. Then standardize on them.

For passenger and light delivery cars—'Royal Cord', 'Nobby', 'Chain', 'Usco' and 'Plain'. Also tires for cycles, airplanes and solid tires for trucks.

United States Tires are Good Tires

"Mention The Geographic—It identifies you"

XUM

Spend your Summer in the Pacific Northwest!

Climb its mountains, fish its streams, lakes and bays; golf on its forty evergreen courses; motor on its fifteen thousand miles of scenic highways; visit its national parks, the most popular in America, forest reserves and monuments.

Enjoy its Cool Sunny Climate

Where the temperature is rarely over eighty degrees on the hottest days and where you can have a sound sleep every night. Special summer excursion fares.

Write for free illustrated booklet to any commercial organization in Oregon, Washington or British Columbia, or to Herbert Cuthbert, Secretary, Pacific Northwest Tourist Association, maintained by government funds to give free information. L. C. Smith Building, Seattle.

THE WORLD'S GREATEST OUT OF DOORS

It's not the power it's the traction

The above illustration was suggested by a well known business man who was standing on the curb at the foot of a sharp incline leading to a bridge spanning a river.

The scene made such an impression upon him that he described it to us in detail and urged us to picture it in an ad so that all motorists might learn the lesson he got from it—***"to always put on Weed Tire Chains*** when the roads are wet and slippery."

Here's the Story—

"The bridge had just swung closed and the policeman had given the 'Go' signal. All the motor cars, motor trucks and wagons, a long line of them, started ahead, but right in front of me stood a big car—a beauty—which seemed to me to have as much power as a locomotive, but she didn't move a foot. *Stood like she was anchored*, and I judged the 'clutch was slipping' until I realized that all this time the rear wheels were 'spinning' on the cobble stones like a windmill.

"It surprised me to see a small-power delivery truck with a heavy load turn out and go by the big car and up the grade without any trouble. Then I noticed that the cars that were moving were equipped with Weed Chains while *the big car had nothing but slippery, bare tires.*

"Here was the driver of the big car, with all its tremendous power, standing still, wasting time and *wearing out his tires* spinning on a rough, uneven road. And when I thought of what those big 36x5 tires cost and how they were being ruined, *it taught me a lesson* I will never forget.

"In the past few years I have read over and over again how Weed Chains gave positive traction and *prevented slipping and skidding*, but I never saw it so vividly portrayed.

"If every motorist could see it in the same way, *not a single one would attempt to drive* on slippery streets or pavements without Weed Tire Chains."

We are glad to put our friend's story into print and hope the lesson will "strike home" to a lot of drivers who have been either careless or indifferent about using Weed Chains—one of the most important factors in sane motoring.

American Chain Company, Inc.

BRIDGEPORT CONNECTICUT

In Canada: Dominion Chain Company, Limited, Niagara Falls, Ontario

Largest Chain Manufacturers in the World

The Complete Chain Line—All Types, All Sizes, All Finishes—From Plumbers' Safety Chain to Ships' Anchor Chain.

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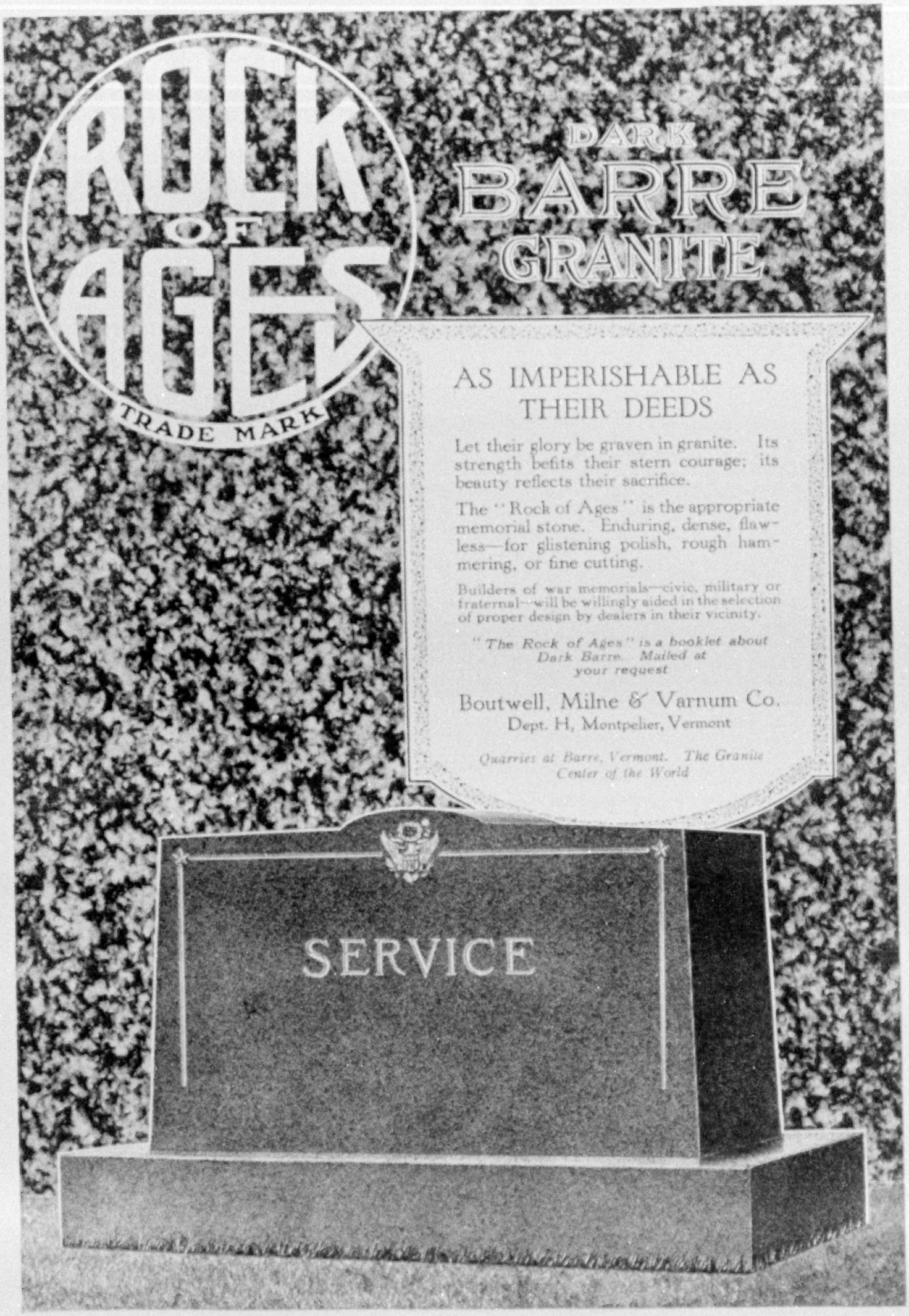
ROCK OF AGES
TRADE MARK
DARK BARRE GRANITE
AS IMPERISHABLE AS THEIR DEEDS
Let their glory be graven in granite. Its strength befits their stern courage; its beauty reflects their sacrifice.
The "Rock of Ages" is the appropriate memorial stone. Enduring, dense, flawless—for glistening polish, rough hammering, or fine cutting.
Builders of war memorials—civic, military or fraternal—will be willingly aided in the selection of proper design by dealers in their vicinity.
"The Rock of Ages" is a booklet about Dark Barre. Mailed at your request
Boutwell, Milne & Varnum Co.
Dept. H, Montpelier, Vermont
Quarries at Barre, Vermont. The Granite Center of the World
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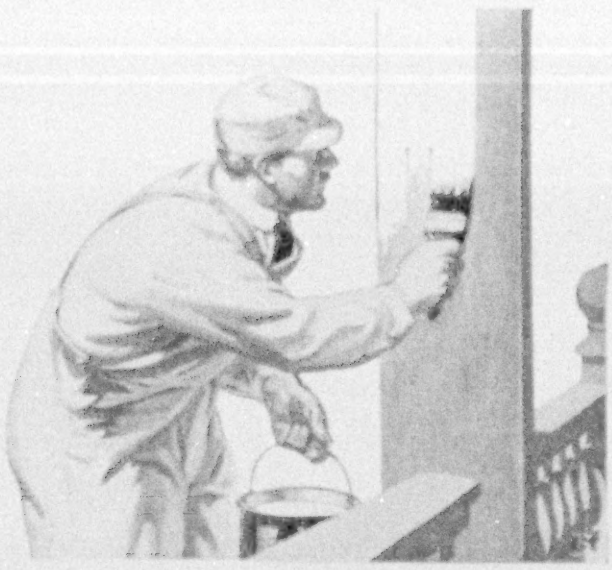


PROTECTION

If it were not for Paint practically everything made of wood would disappear.

Houses and their furnishings, factories and their products, railroads and their equipment could not last without a film of paint to protect them from the destroying forces of rust and decay.

Paint, to serve its greatest use, must *protect* and the ingredient that gives paint its greatest protective power is Zinc.

For years we have met the requirements of the paint industry with just the right quality of Zinc Oxide for its needs.

Our seventy years experience, our unequalled wealth of Zinc Ore, our exclusive processes and our intensive research work, guarantee to all users of Zinc products a quality and a service that are both dependable and exceptional.

THE NEW JERSEY ZINC COMPANY, *160 Front Street*, New York

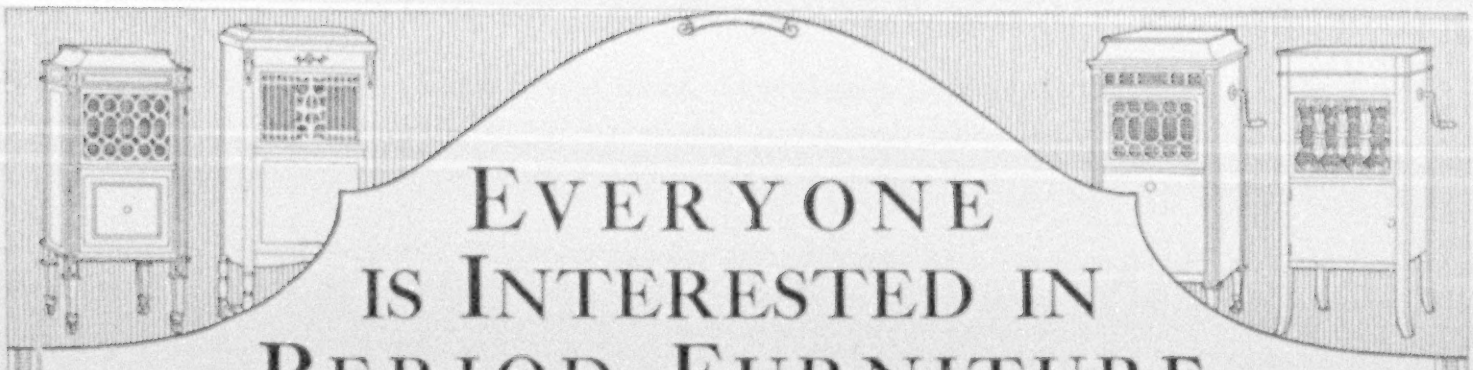
ESTABLISHED 1848

CHICAGO: Mineral Point Zinc Company, 1111 Marquette Building

Manufacturers of Zinc Oxide, Spelter, Spiegeleisen, Lithopone, Sulphuric Acid, Rolled Zinc Strips and Plates, Zinc Dust, Salt Cake and Zinc Chloride

The world's standard for Zinc products

New Jersey zinc



EVERYONE IS INTERESTED IN PERIOD FURNITURE

THE fame of such designers as Chippendale, Heppelwhite and Sheraton endures like the fame of Shakespeare. The genius of these old masters wrought so great an artistry and grace in the furniture which they created that cultured people today insist upon its reproduction or adaptation for modern needs.

The history of artistic furniture design began several hundred years ago and perhaps it is not too much to say that it ended with the eighteenth century. Progressive phonograph manufacturers for several years have offered their phonographs in expensive period cabinets running into thousands of dollars in cost. The Edison Laboratories reproduced various famous cabinets at prices ranging as high as six thousand dollars.

It was characteristic of Mr. Edison that he said: "If period cabinets are desired by people who are willing to pay several thousand dollars for an Edison Phonograph, why not put all Edison Phonographs into period cases and let everyone have the best there is in cabinet design?"

Mr. Edison's word is law at the Edison Laboratories. Henceforth (with the exception of two models designed for summer cottages) each and every New Edison—no matter what its price—will be encased in a period cabinet.

The NEW EDISON

"The Phonograph with a Soul"

HOTEL COMMODORE
New York City
25 June, 1919

THESE wonderful new moderately priced Edison period models will be on exhibition for the benefit of the furniture lovers of New York City and vicinity, ten A. M. to five P. M. June 25th. Those who do not live in the Greater New York district will find their local Edison dealer glad to give full information concerning the new models.

Our new de luxe catalog, a complimentary copy of the magazine Along Broadway and the booklet What the Critics Say will be sent you from the Edison Laboratories upon request.

can now be obtained in artistic and authoritative period cabinets from $155 to $6000. The new line of moderately priced period models ranges from $155 to $300. NOTE: When you buy the New Edison in Mahogany, you get *genuine* mahogany and when you purchase it in oak, you get *selected* quarter sawed white oak of the *highest quality*.

The Official Laboratory Model, also known as "The Three Million Dollar Phonograph," sells at $285. It is furnished in Chippendale or William and Mary, at the election of the purchaser.

THOMAS A. EDISON, Inc.
ORANGE, N. J.

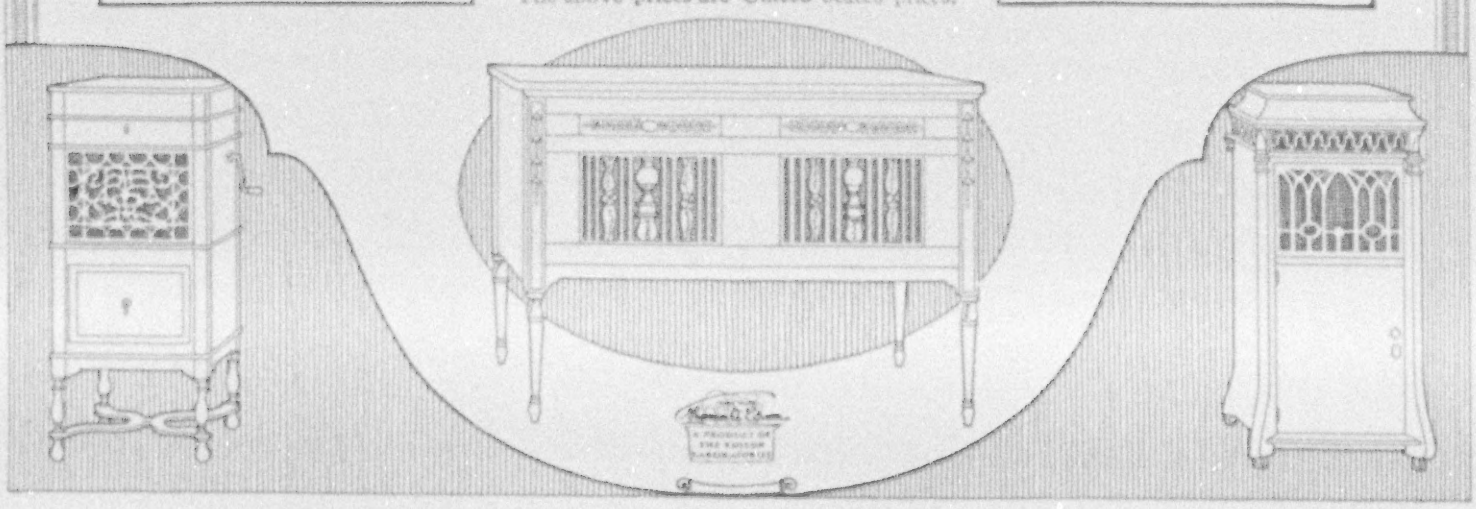
The above prices are United States prices.

MISS ELSIE DE WOLFE
of New York City

AMERICA'S most celebrated designer of household interiors has placed the stamp of her approval on these new cabinets:

"The period cabinets which Mr. Edison has adopted for his phonographs are in pleasant contrast to the rather grotesque cases which one so frequently sees. From the characteristically diminutive and graceful Heppelwhite to the costly replicas of historic pieces, the superior furniture value of Edison cabinets can scarcely fail to impress the lover of good furniture."

Elsie de Wolfe



Vacation in the Pine Scented Lakelands of Canada

In the "Highlands of Ontario," that wonderful region of scenic beauty, you can Fish, Swim, Golf, Canoe, Camp, Hunt—spend a vacation you will never regret or forget. Mirror-like lakes set in the grandeur of forests of pine and balsam. The purest of air, 1,000 to 2,000 feet above the sea, and hay fever is unknown.

Famous Playgrounds for Outdoor Men and Women

"Algonquin Park"—"30,000 Islands of Georgian Bay" — "Kawartha Lakes"—"Muskoka Lakes"—"Timagami" and the "Lake of Bays." Modern hotels—or "rough" it if you prefer. Any Grand Trunk Agent will gladly plan your trip for you. Write any of the following for descriptive literature:

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For adults', boys' or girls' camp sites, apply to H. R. Charlton, General Passenger Department, Montreal.

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Have asked us for our "Questionnaire for Investors"—the most striking, popular and valuable piece of literature we have ever published. It tells how to test the safety of any investment and to distinguish the sound from the unsound.

We have left only a few copies of the Questionnaire. Call or write today if you wish a copy of this invaluable booklet. It is sent without charge or obligation. Ask for

Circular No. E-908

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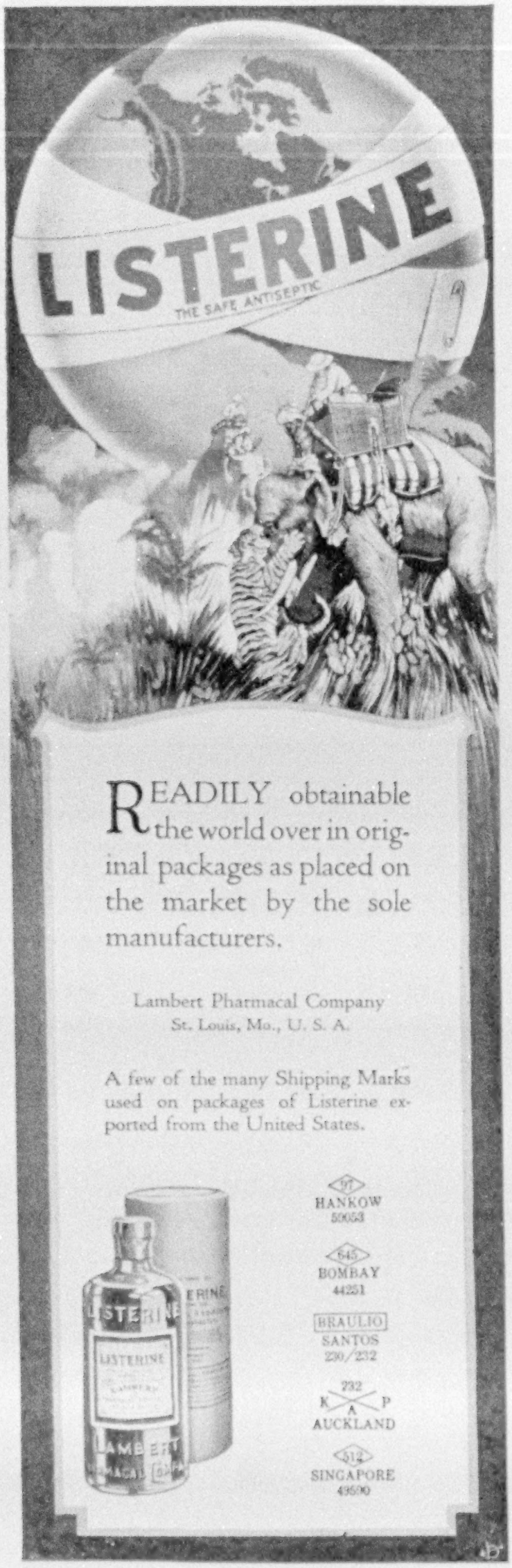

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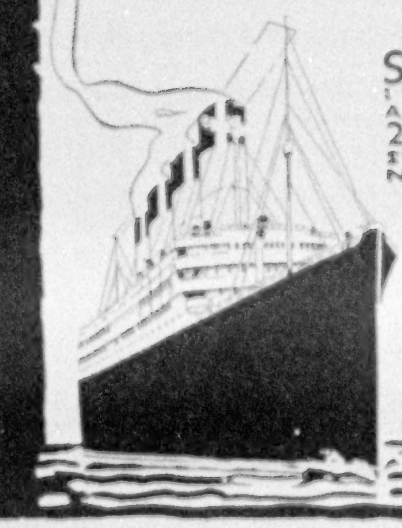

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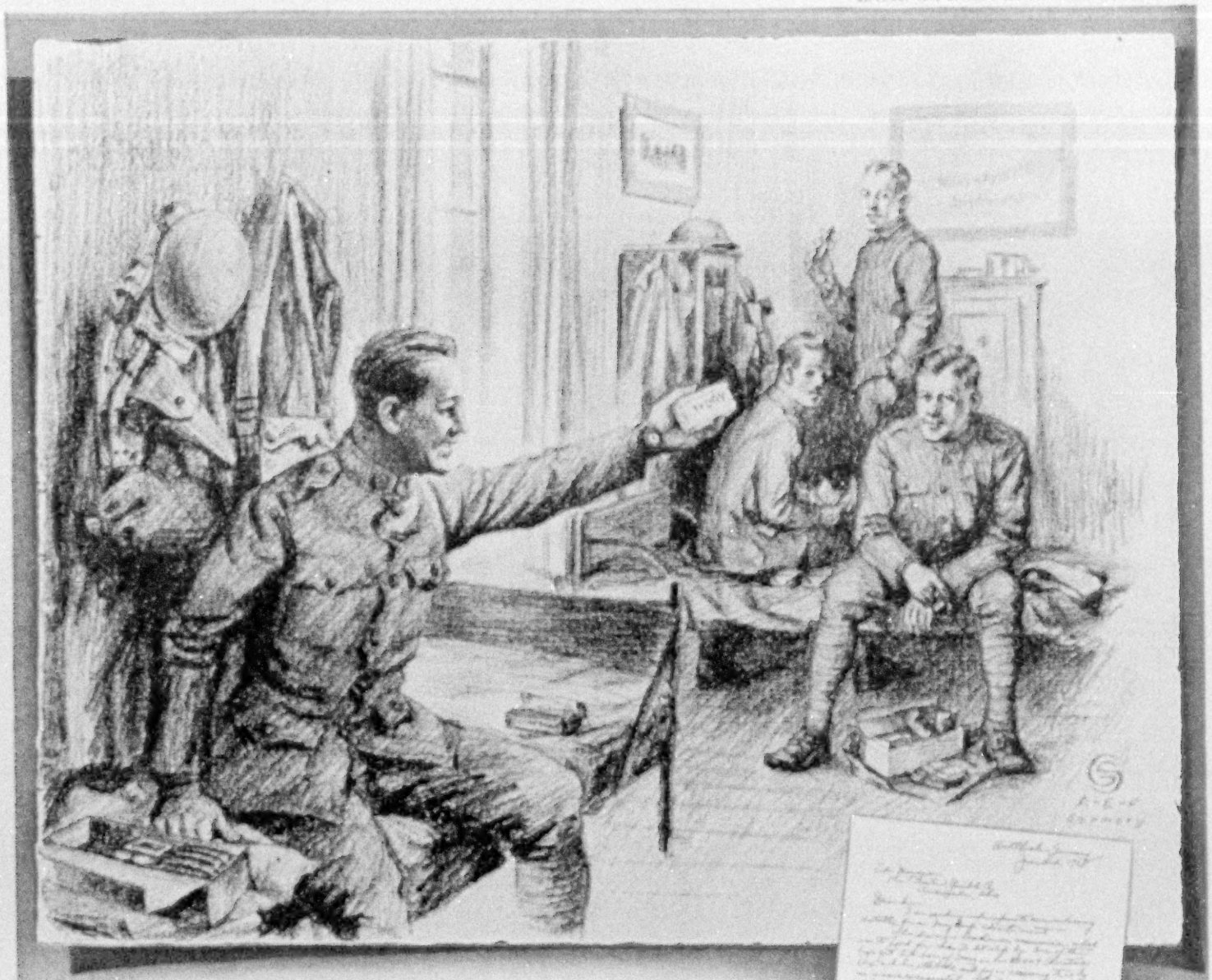

A picture and a letter from one of the doughboys in the Army of Occupation

Wittlich, Germany, Jan. 2nd, 1919.

Adv. Manager, The Procter & Gamble Co.,
Cincinnati, Ohio

Dear Sir:

I am sending under separate cover a drawing suitable for an Ivory Soap advertisement.

This drawing is based on an occurrence which was too good for me to let slip by. One of the boys got two bars of Ivory in his 3x4x9 Christmas box and his attitude and joy in receiving it, is by no means exaggerated in the drawing. Ivory leaves a feeling of freshness and cleanliness that can't be equaled. We were able to get it at a commissary down in the Vosges about three months ago, but haven't seen any since.

The background of the drawing will picture somewhat the comfort in which the Army of Occupation is now living. Our quarters are in a former seminary and we have all the conveniences of a college dormitory.

Though the drawing is done on the only paper available and not on the usual 30 x 40 illustration board you are accustomed to see, I'm sure it will reproduce well. An advertisement could be written around it for next Christmas or it can be used in the near future, as a good many of us shall remain here for a long time and boxes will come as long as any of us remain.

Yours very truly,

Sgt. George W. Straub,

Co. C, 326 F. Sig. Bn., American E. F., A. P. O. 792.

VOL. XXXV, No. 5 WASHINGTON MAY, 1919

THE NATIONAL GEOGRAPHIC MAGAZINE

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THE INDUSTRIAL TITAN OF AMERICA*

Pennsylvania, Once the Keystone of the Original Thirteen, Now the Keystone of Forty-eight Sovereign States

By John Oliver La Gorce

Author of "The Warfare on Our Eastern Coast," "Roumania and Its Rubicon," etc.

TO ATTEMPT a survey of the Commonwealth of Pennsylvania in a magazine article is akin to describing an empire on a sheet of note paper; for more than a dozen of the sovereign nations of the earth as they were in the years before the Prussian ran amuck were smaller in area, and more than half of the rulers of the world governed fewer people than live within the confines of that State.

With vast natural resources, immense industries, plus the unconquerable spirit of progress that tends to create local happiness and national well-being, the Keystone State, as it is proudly called, challenges admiration and stirs the imagination.

Measured in terms of our own country, Pennsylvania has many surprises for the investigator of its position in the Union. One might add the populations of four far-western States to that of all New England and still have fewer people than dwell in the land of William Penn. Draw a line from the Canadian border to the Rio Grande on the meridian that separates the Dakotas and Nebraska from Montana and Wyoming, and all of the people who live between that line and the shores of the Pacific would barely suffice to equal Penn-land's population.

Traveling through the State, one quickly gathers the impression that it is peopled with foreign-born. Its vast industries have laid heavy drafts upon the labor markets of the world in times gone by, and for years not a ship that carried an immigrant to America came without a quota bound for the iron, steel, and coal centers of the Commonwealth.

MANY NATIONS HAVE CONTRIBUTED TO THE STATE'S ARMY OF LABOR

An analysis proves, however, that even with the influx of alien labor, Pennsylvania outranks every other State in the Union in the number of sons and daughters of native parentage. Even New York has a million fewer people whose parents were born under the ægis of the American flag.

Still, the State is distinguished for its great number of foreigners. No other State has so many Welsh, Austrians, or Hungarians. It has more Welsh than County Radnorshire, more Austrians than the Province of Salzburg, more Hungarians than any two cities in Hungary, Budapest excepted. It has as many English as the counties of Cambridge

* This is the first of a series of articles on Our States.

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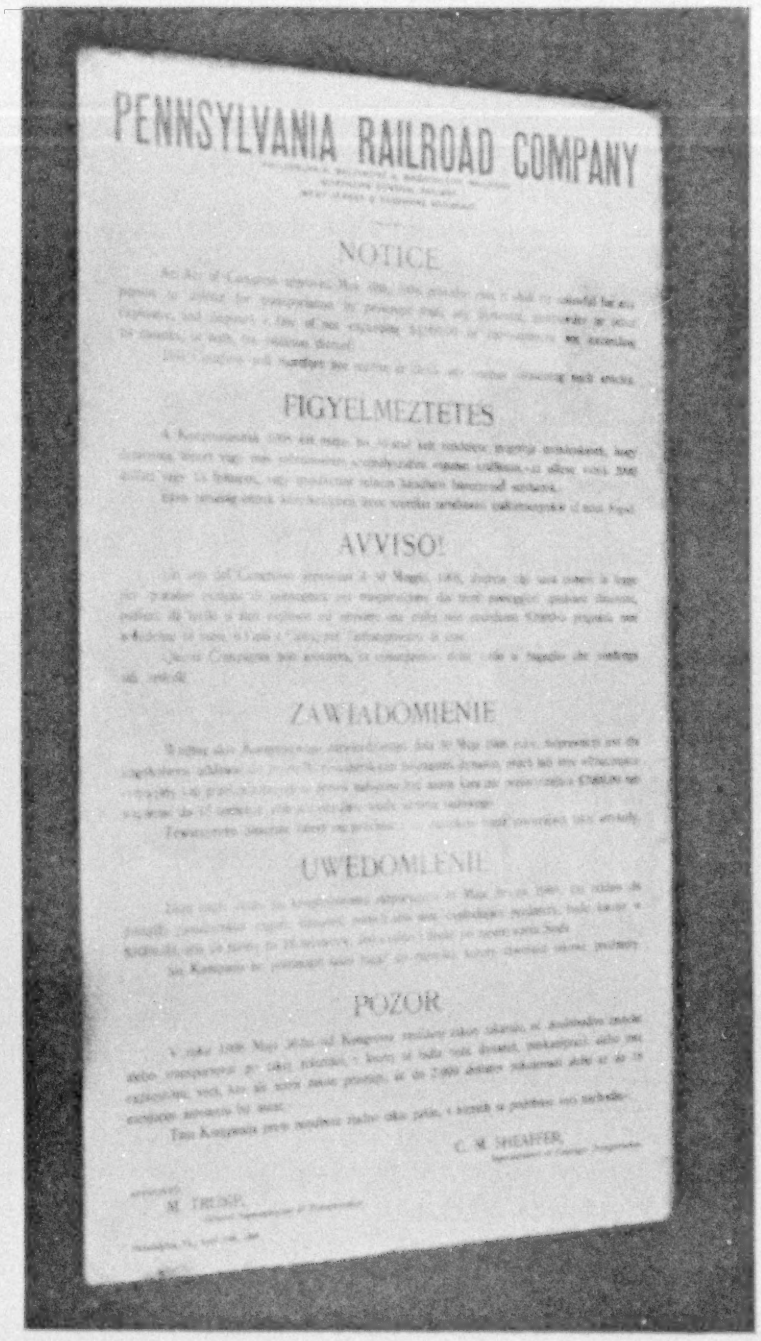

PENNSYLVANIA RAILROAD COMPANY

NOTICE

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POZOR

C. M. SHEAFER

A LAND OF MANY TONGUES

The cosmopolitan make-up of the population of Pennsylvania is shown by the above notice in six languages, posted in railway stations, warning the public against the transportation of explosives on passenger trains.

and Oxford together; as many Irish as County Kerry; as many Scotch as County Clackmannan; as many Russians as the Government of Kharkov.

ESSENTIALLY A THRIFTY PEOPLE

Pennsylvanians are not alone distinguished because of the large numbers who boast of native ancestry, for an examination of the census returns dealing with the ownership of the homes of the people of the nation reveals the fact that it has more home-owners than any other State. They are essentially a thrifty people. Nearly seven hundred thousand families live under their own roof-trees—and the striking part of that situation is that most of these homes are mortgage-free.

Many men have essayed to look into the future of the American people to see what the United States will be when the nation reaches its maturity. Perhaps Pennsylvania can supply the answer. When one travels through the farming and industrial section of the southeast, visits the anthracite country of the northeast, wanders around through the splendid valleys of the central section, and then goes into the bituminous and manufacturing region beyond the Alleghenies, he marvels at the number of people who find there a homeland, and at the tremendous volume of business which has been developed.

Yet Pennsylvanians know that there is room in the State for millions more, and see no reason why the country at large cannot support a population as dense as that of the Keystone State today. Such a density of population would make ours a nation of half a billion souls—more people than inhabit the entire continent of Europe.

The manufacturing industry of the State is an epic of human energy. What bit of fiction could thrill more than the facts showing how one-twelfth of the people of the United States, the busiest nation on earth, can succeed in producing one-eighth of the Republic's manufactures and more than a fourth of its minerals! Or what story could appeal more than the one which tells how a district constituting only a thousandth part of the earth's land surface and possessing only one-half of one per cent of the earth's people produces one-sixth of the world's pig iron and the same proportion of its coal!

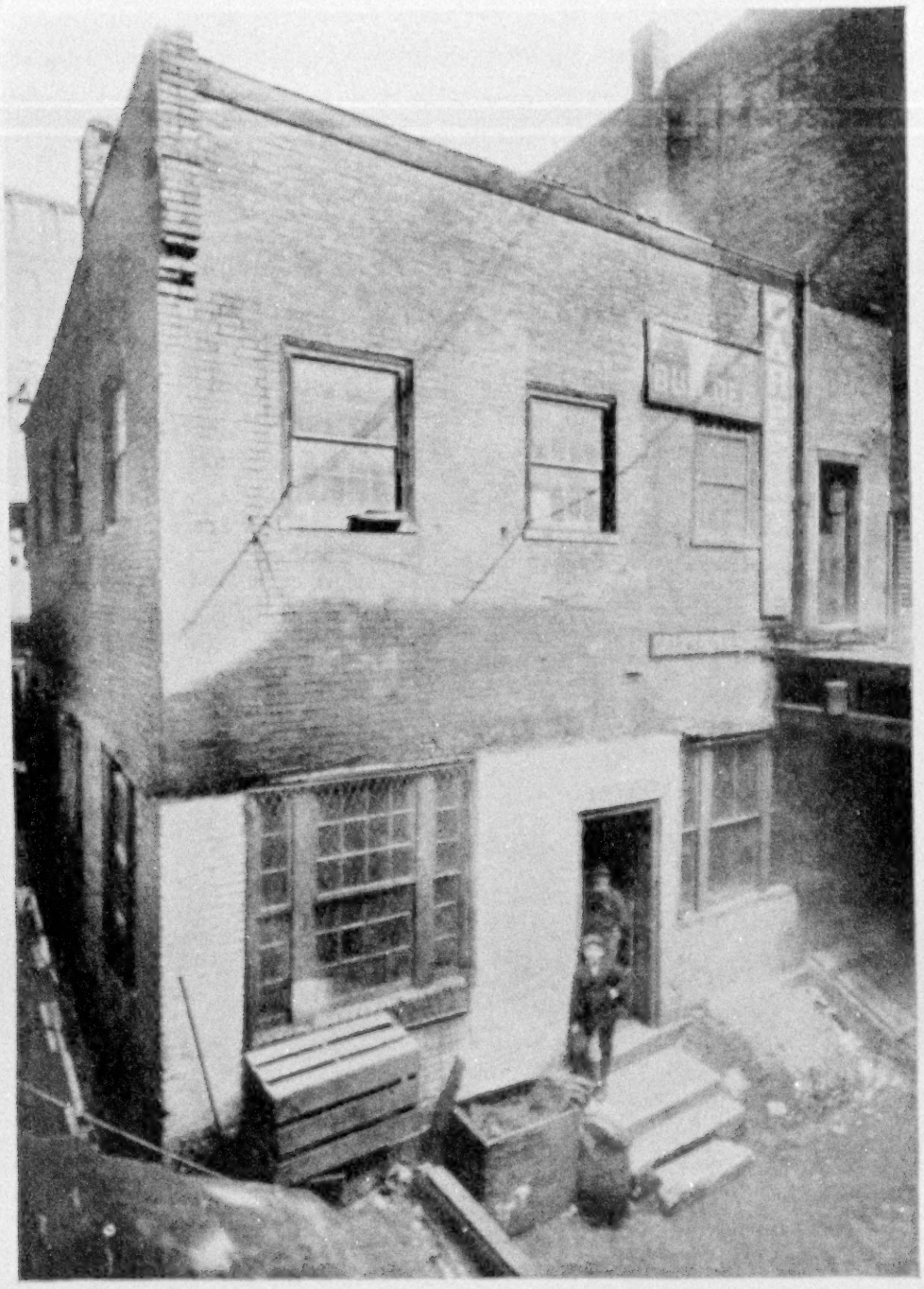
WHERE MANY INDUSTRIES THRIVE

Yet, with all of this concentration, Pennsylvania has a greater diversity of industries than any other State, leading

both New York and Illinois in that particular. This versatile geographic Titan forges the heaviest castings civilization has ever undertaken to make and the most delicate micrometers that science demands for traversing the realms beyond the millionth of an inch.

With equal success it fabricates tremendous testing machines that squeeze metals to the tune of millions of pounds, and makes watches whose balance-wheels measure time down to the hundred-thousandth part of a second, and chronometers that do, mayhap, even ten times better than that.

Wide-ranged, yet concentrated, famous for its heavy manufactures, distinguished for its light ones, demanding the most powerful forges in the world, requiring the most delicate turning machines, producing raw iron which formerly could be bought for less than a cent a pound, and finished steel worth, in some cases, hundreds of dollars an ounce, Pennsylvania commands admiration for her manufacturing industries and compels attention for her position in the commercial world.



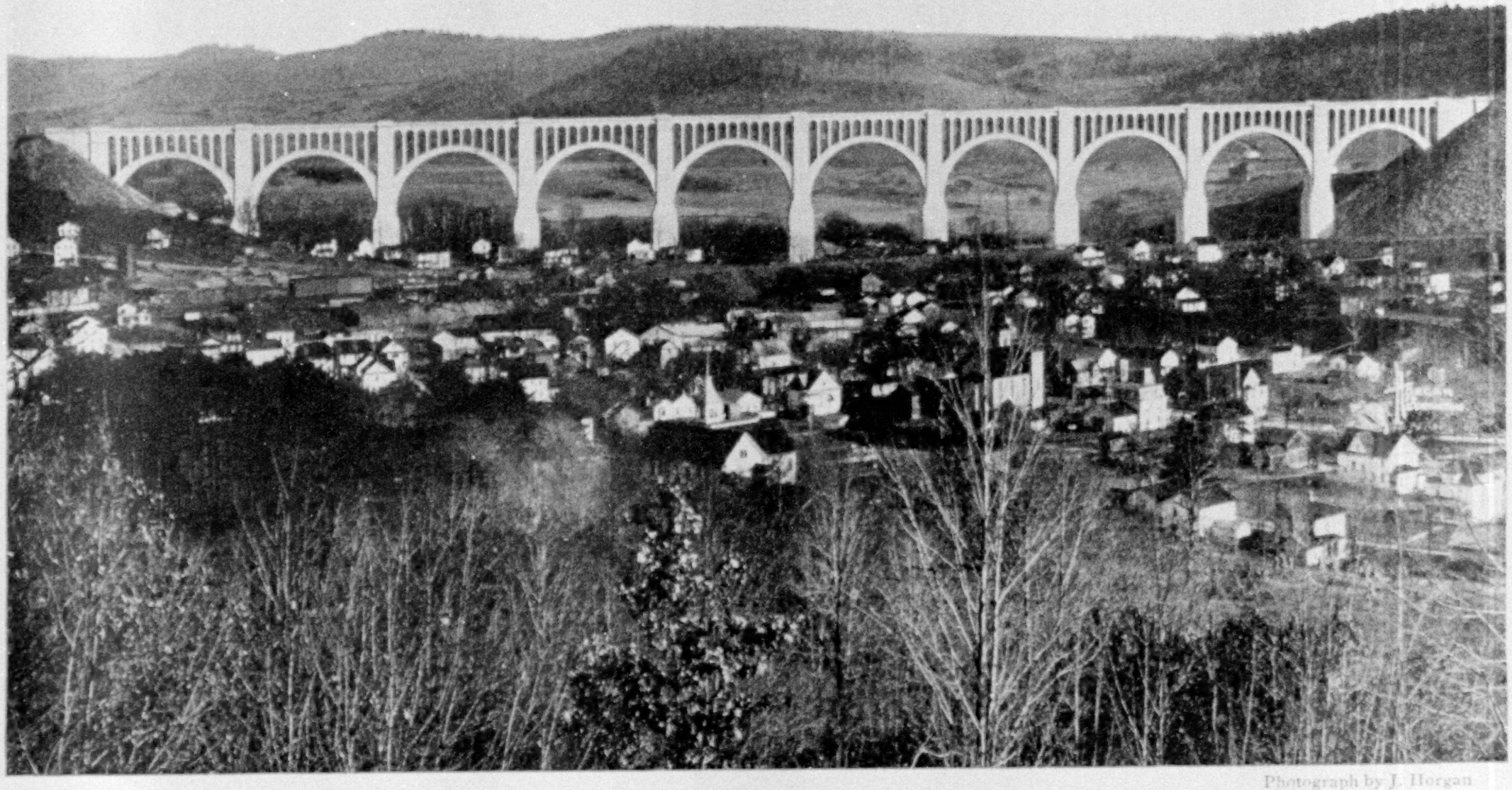
© A. Lloyd Lewis

THE FIRST UNITED STATES MINT: PHILADELPHIA

The first production of this mint was the copper cent of 1793, followed the next year by silver dollars, and in 1795 by gold eagles. In addition to its modern coinage establishment in Philadelphia, the United States now has mints in operation in San Francisco and Denver. The nation's paper money is made in Washington.

Some one has observed that Pennsylvania bridges span most of the rivers of the earth, and that Pennsylvania locomotives run over Pennsylvania rails in the Occident and Orient alike, across Arctic wastes and through tropical jungles, through the heart of civilization and on the border of savage-land. The clatter of the iron pig of Pennsylvania is heard throughout the world, along with the squeal of the edible porker of Illinois.

The State makes nearly half of the country's cotton lace, more than a third of its carpets and rugs, more than a third of its chocolates and cocoa, nearly half of its felt hats, and more than a third of its silk. It produces more asbestos manufactures than all the rest of the country, and more bluing, ice cream, hammocks,

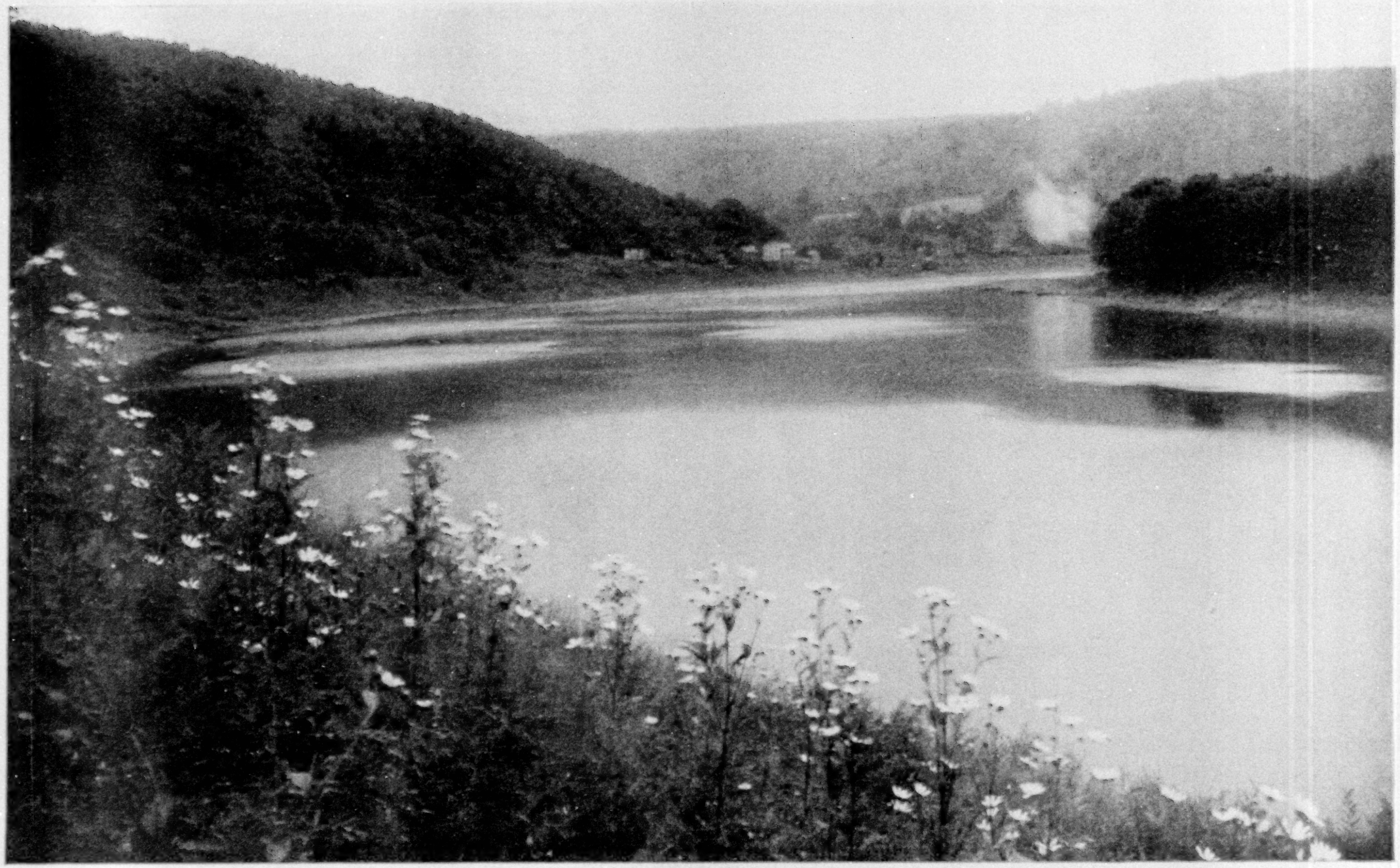


Photograph by J. Horgan

SUPERB IN SYMMETRY, ENDURING AS THE SURROUNDING HILLS: THE VIADUCT AT NICHOLSON, PENNSYLVANIA

As the leading State in the Union in the production of Portland cement, Pennsylvania employs it generously in the construction of bridges and viaducts. At Nicholson and Towanda are two of the most imposing concrete structures in the world (see page 381).

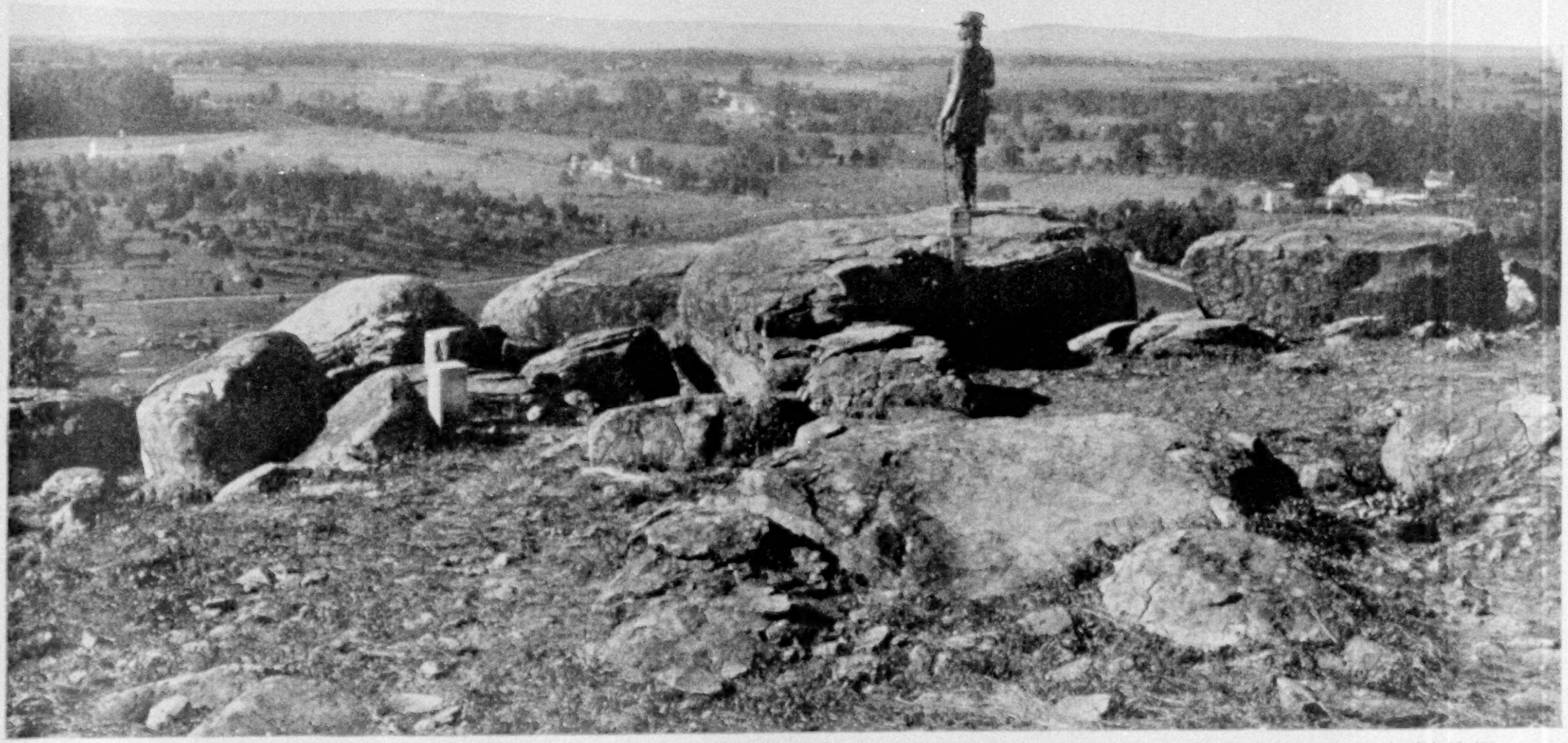
XUM



Photograph by William H. Rau

ALONG THE FLOWERY BANKS OF THE PLACID UPPER REACHES OF THE SUSQUEHANNA

Flowing now between steep and forbidding cliffs of towering granite, now between daisy-bordered banks, now through fertile farm lands, and now through swampy sections, the Susquehanna has a course of 500 miles, draining the greater part of Pennsylvania and serving many prosperous and populous cities. Harrisburg and Wilkes-Barre are the chief cities on its banks.



Photograph by W. H. Tipton

THE GETTYSBURG BATTLEFIELD FROM LITTLE ROUND TOP, SHOWING WARREN STATUE AND OVERLOOKING THE VALLEY OF DEATH TO THE WHEAT FIELD, PEACH ORCHARD, AND BLOODY ANGLE

It is a short 112 miles, in a direct line, from Independence Hall, where the American Union was born, to that fateful clump of trees on the battlefield of Gettysburg, where the "high tide of the Confederacy" began to recede and the Union was saved. The battlefield covers about 25 square miles, with the Union line stretching along Cemetery Ridge from Round Top to Culp's Hill, and the Confederate line paralleling it along the crest of the lesser Seminary Ridge. The 400 monuments on the field rise in gardens, by the roadside, on stony ridges, in the woods, in the open country, each telling a story of devotion to duty as each hero saw it. To assist students and sightseers in interpreting the historian's account of this, one of the decisive battles of the Civil War, the positions held by various commands have been clearly marked.

and leather than any other State represented on our starry flag.

A VERITABLE TREASURE-HOUSE

As might well be imagined, such versatility in its manufacturing industries, coupled with seemingly endless natural resources, has created great wealth. Therefore, when it is stated that the estimated true value of all the property in the Commonwealth amounts to more than fifteen billion dollars, on a pre-war basis of values, the mind fails to grasp its full meaning. But when one stops to consider that this is four billion dollars greater than the aggregate wealth of all New England and only five billion less than the national wealth of all Italy, the significance of the figure begins to appear.

With this epitome of the State's rôle as a component part of a powerful nation, one's interest turns to the elements of its greatness. Politics gave it the familiar sobriquet—Keystone State. Yet even politics is a matter of geography. Six colonies lay to the east and north of Pennsylvania and six to the south, so it was the geographical keystone of the embryo nation. The early development of its iron deposits and opening up of its coal mines made it preëminently an industrial keystone.

By the time its limited supplies of iron ore were exhausted the industries based thereon had become so well established that even the discovery of unprecedented deposits of ore in Michigan and Minnesota could not break the State's position of leadership in those fields. The Mountain of Manufacture refused to go to the Mahomet of Ore, so the Mahomet of Ore came down the Great Lakes to the Mountain of Manufacture.

Coal and limestone are as essential in the production of iron and steel as is the ore itself, and Pennsylvania has both in as great abundance as Minnesota has iron. Furthermore, heavy manufacturing seeks the neighborhoods of rich coal deposits as unerringly as the needle seeks the magnetic north.

THE VALUE OF A FAVORED LOCATION

By favor of location as well as by richness of resource, Nature made Pennsylvania a great State. Call the roll of the forty-eight commonwealths of the American Union and another will not be found that shares with the land of Penn the honor of being in navigable connection with three of the nation's water fronts—the Atlantic Ocean, the Gulf of Mexico, and the Great Lakes.

Through the Delaware River the shipping of the world may come to the very foot of the chief street of her principal city. Down the Ohio the wealth of her mines may float, through the very heart of the nation, to New Orleans and the Gulf of Mexico. At Erie are touched the broad waters of the unsalted seas, where the raw materials and the finished products of the West and East flow back and forth in the busiest water-borne commerce in the world.

With the Delaware River meandering southward in such a way as to give the State two great salients into New Jersey; bounded on the north by the forty-second parallel and a bit of Lake Erie; separated from Maryland and West Virginia by Mason and Dixon's Line, and from Ohio by one that runs nearly midway between the eightieth and eighty-first meridians, the State is a parallelogram except for the wandering course of the Delaware River, the arc of Delaware State, and the jog up to Lake Erie.

THE ROLL-CALL OF COUNTIES

From the Maryland line to the New York line is 158 miles, while from the Ohio line to the deepest salient in the Delaware River sector, between Trenton and Bristol, is 306 miles. The diversity of physical aspect, soil, and resource is great. Southeast of the Blue Ridge Mountains lies one of the finest agricultural regions east of the Appalachian chain. Franklin, Adams, Cumberland, York, Lancaster, Lebanon, Berks, Bucks, Montgomery, Chester, and Delaware—was there ever a group of counties with fairer farms than these possess?

Then come the eastern mountains and beyond, the wonderful succession of ridge and hollow that embraces the anthracite mines, the slate quarries, the cement rock beds, and so much else of the State's resources. Further westward is the great Allegheny upland region, whose deposits

XUM

OIL CITY AND THE ALLEGHENY RIVER

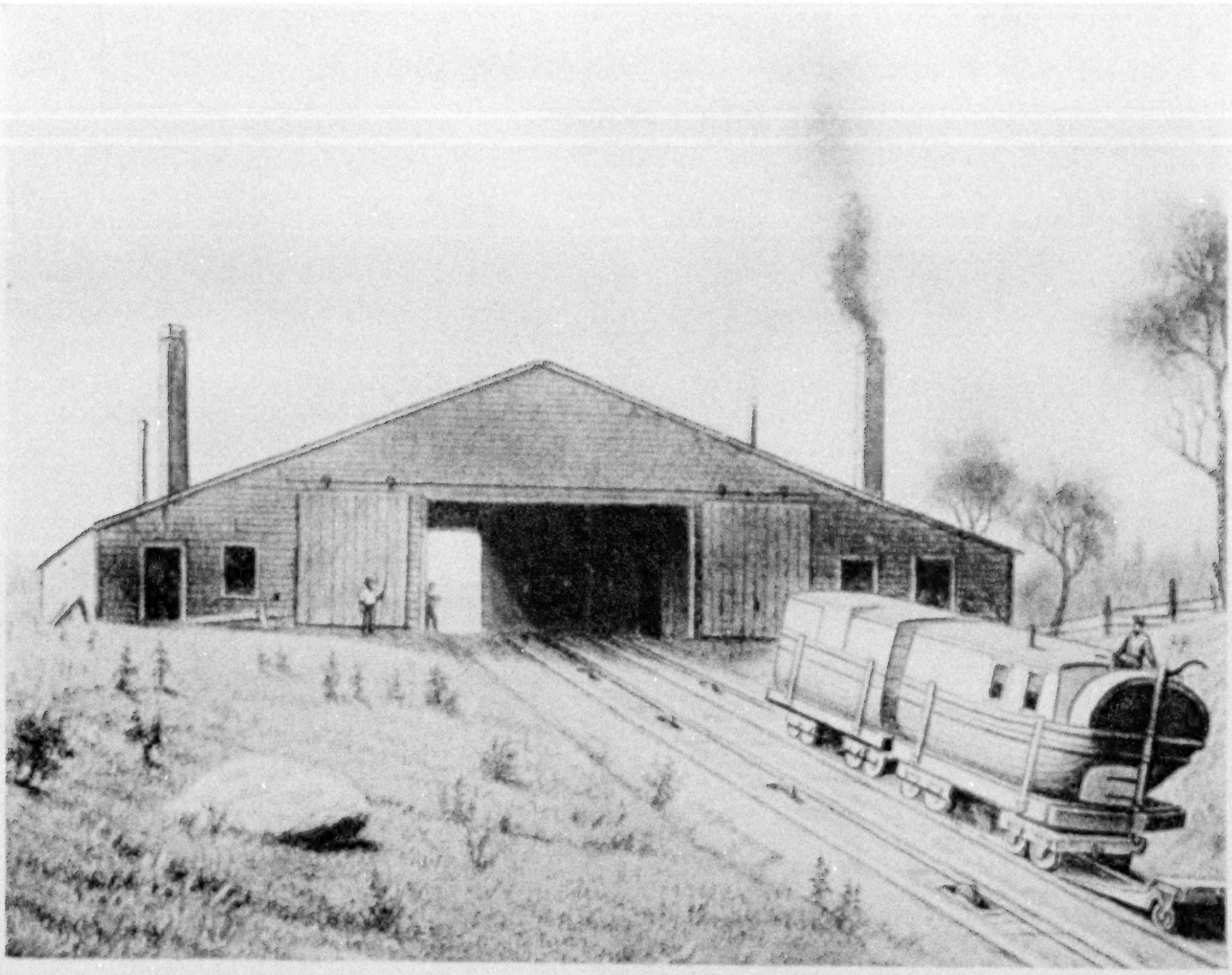
It was western Pennsylvania that taught the world the use of petroleum and sent that substance on its grand march around the globe. Situated 55 miles southeast of the Erie shore, Oil City is the center of the great oil district of Pennsylvania. It is estimated that in ten years there was a yield of sixty million barrels of oil from the valley of Oil Creek, which flows into the Allegheny River at this point. Although the present yield is inconsiderable, compared with the heyday of the oil flow, Oil City is still an important industrial center, with its numerous oil refineries, machine shops, and foundries.

of bituminous coal are richer than all the gold mines of the earth.

A CANAL EQUIPPED WITH AMPHIBIOUS BOATS

A high plain, undulating in wide, low swells, and gently descending southward and southwestward, this area comprises more than half of the territory of the State. Its oil and its gas have been almost exhausted under the demands of industry, but its coal mines go on and on, yielding more fuel in a year than all the world produced at the beginning of the American Civil War.

With its unequalled situation as respects the navigable waters of the nation, it was but natural that Pennsylvania should have early taken steps to develop her inland waterways. A hundred million dollars were spent in the building of canals to handle the State's commerce. Public appropriations and private funds alike were made available for the build-



Photograph courtesy Philadelphia Commercial Museum

NAVIGATING THE PENNSYLVANIA HILLS IN A BIFURCATED BARGE

A view of the old canal-boat inclined railway across the Alleghenies between Hollidaysburg and Johnstown. Over this route passed the traffic between Philadelphia and Pittsburgh a century ago.

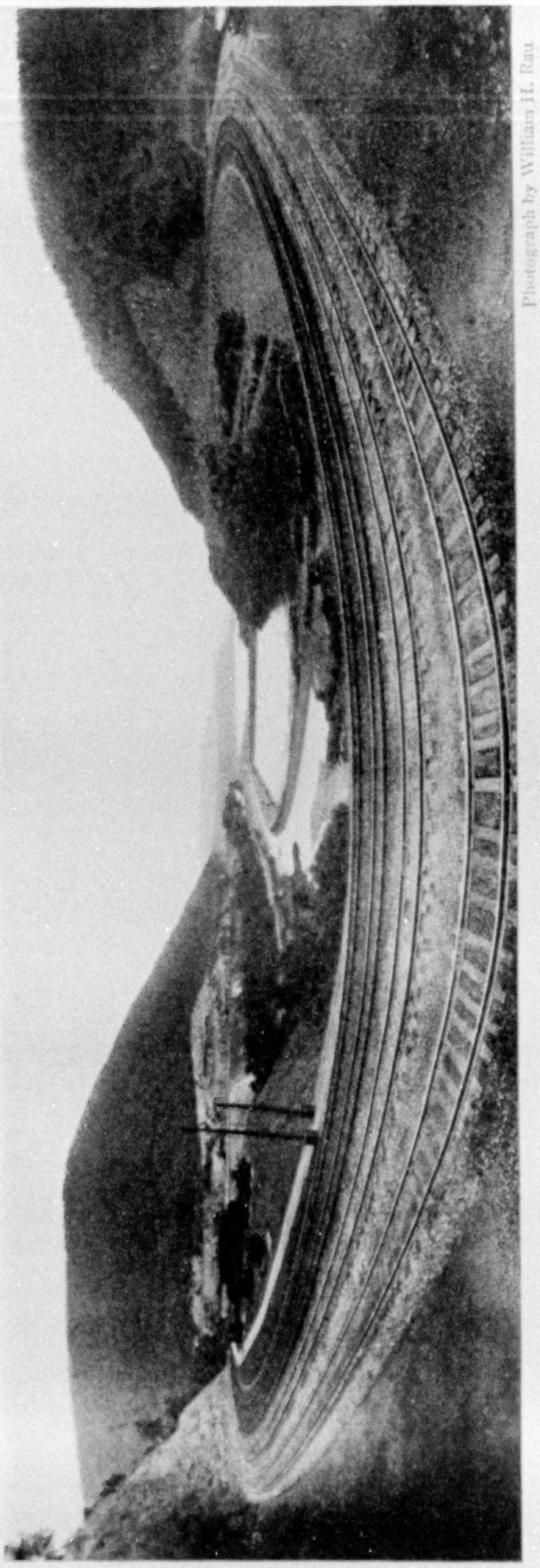
ing of a network of waterways. As time went on, these spread out over the State like the branches of a tree.

The Schuylkill Navigation Company built a 108-mile canal up the Schuylkill River, and at one time had a thousand boats in operation. The Union Canal, from Middletown to Reading by way of Lebanon, was 77 miles long, with a 22-mile branch. It had more than a hundred lift-locks. Sixteen of these were in a tunnel just west of Lebanon, carrying the canal to Swatara Creek. The Monongahela was canalized by the construction of sixteen dams in order to form slackwater navigation.

The Main Line Canal, connecting Philadelphia with Pittsburgh, was in reality half canal and half railway. The journey began at Broad and Vine streets, Philadelphia. From there to Columbia, on the Susquehanna, sectional canal-boats and railway cars were hauled on wheeled trucks. There the boats were pinned together and towed up the Susquehanna and Juniata rivers to Hollidaysburg. Here they were put on an inclined railway, dragged up the mountain by steam winches, and let down by the same method to Johnstown. From there they proceeded to Pittsburgh through the Conemaugh, Kiskiminetas, and Allegheny rivers.

WAGING A LOSING BATTLE

Inadequately constructed to meet the competition of the railroads, as the latter transportation facilities improved and expanded, the canal system began to fail and now is practically in ruins. Everywhere one sees decaying locks and rotting canal-boats, relics of a remarkable era. But recently the strain of the tremendous volume of local and through



Photograph by William H. Rau

THE FAMOUS HORSESHOE CURVE ABOVE ALTOONA

Beyond Altoona, on the railway line from Harrisburg to Pittsburgh, the train gradually ascends to the summit of the Alleghenies. At Kittaning Point the line is carried around the famous Horseshoe Curve, where it crosses two ravines on a lofty embankment and cuts away the promontory dividing them. As the sides of the curve are parallel, trains which are seen to be moving in the same direction on opposite sides of the curve are actually bound for different terminals.

traffic is too great, even for the splendid railroad systems of the State, and there is a strong movement to rehabilitate the canal system and to extend it.

Tentative plans have been formulated to connect Pittsburgh with Lake Erie by a canal which will touch Ohio at Beaver, enabling the ores from Minnesota and Michigan to come into the Pittsburgh district by water, and the coal from the bituminous regions to float practically from the mouth of the mine to the Northwest. Plans have also been made to bring Philadelphia into touch with New York waters by a canal across Jersey from the Delaware at Trenton, to Raritan Bay at South Amboy.

It is almost impossible for the layman to realize what vast advantage there is in canal transportation for heavy and slow freight. It costs but little more to bring ore from Duluth, at the head of the fresh-water seas, to Erie and Conneaut and Ashtabula, nearly a thousand miles, than it costs to haul it from the Erie ore piles to the Pittsburgh furnaces, less than 125 miles.

CUTTING DOWN THE DISEASE HARVEST

In matters of health Pennsylvania has always been one of the forward-looking States. It long ago came to realize that the Commonwealth which is willing to give its

Photograph by J. Horgan

CITY HALL AND SOLDIERS' MONUMENT IN SCRANTON, PENNSYLVANIA

Probably no other city of its class in the world is richer than Scranton. Five billion tons of anthracite in the hard-coal region have been used or wasted, but fifteen billion tons have not yet been touched within a radius of two or three hours' ride of Scranton. Its prosperity is founded upon the civic pride of its people no less than upon its mines.

sanitarians adequate support can go before the world with a clean health slate. In 1906 the State's typhoid death rate was 56.5 persons for each 100,000 population. In 1915 it was 12.2. In other words, Pennsylvania's health agencies are rescuing 3,700 people from typhoid graves every year.

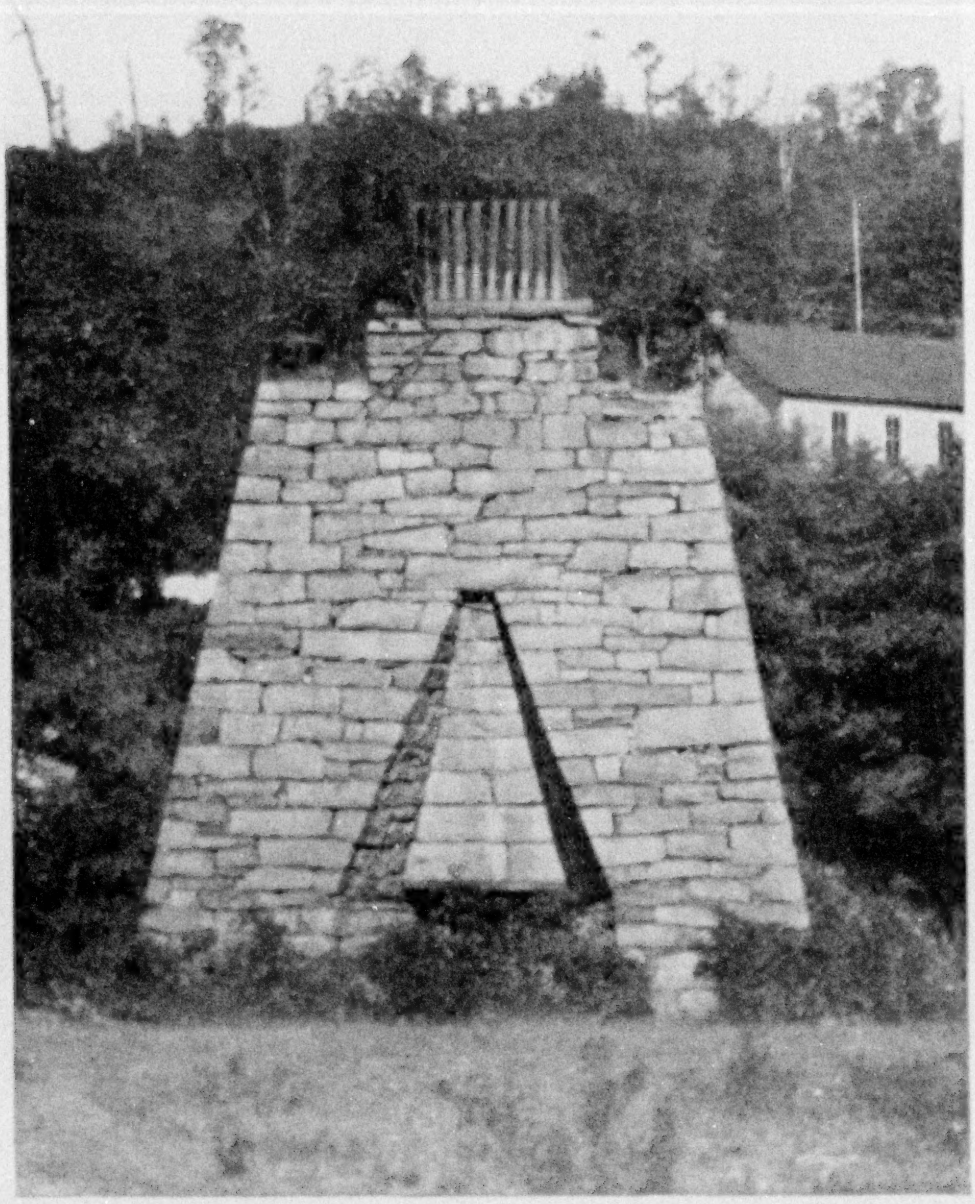
The same situation prevails with reference to tuberculosis. In 1907, 129.6 persons died of that disease out of each 100,000 population. In 1915 there were only 97.8 such deaths—a rescue of 2,600 people from tubercular ends each year.

Through a system of sanitary inspection of water supplies and sewage disposal; through its sanatoriums, its visiting nurses, and free medical aid for the tubercular; through its free antitoxin service in diphtheria and other diseases, and through the employment of all modern agencies for keeping the people free from contagion, the State has won the lasting gratitude of its citizens for the longer, better, and healthier lives it is enabling them to live.

MILLIONS OF SEEDLING TREES PLANTED

Only threescore years ago Pennsylvania was richly provided with forests. A former commissioner of forestry relates how in his youth he traveled through almost unbroken forests of splendid trees from the mouth of the Sinnamahoning to the Allegheny River at Warren—75 miles—and also from Clearfield via St. Marys to Smethport—60 miles. In his day, he says, he has seen one-seventh of the total area of the Commonwealth cut over and made barren and desolate.

Aroused to the necessity of saving her upland soils by restoring to the bare hills and mountain sides the trees that thoughtless industry removed, the State organ-



Photograph by Deck Lane

ONE OF THE EARLY IRON FURNACES IN PENNSYLVANIA

This primitive plant produced in two years less iron, perhaps, than the blast furnace, shown on the opposite page, can produce in a single day. The capacity of the modern furnace is about four hundred tons every twenty-four hours, and it is in operation 365 days and nights in the year.

ized a forestry bureau and acquired more than a million acres, which it is fast reforesting. Millions of seedlings have been planted and the work is but well begun. Corporations, the public schools, and institutions of many kinds have joined in a general movement to restore every acre of waste land to the condition which existed before the woodman's axe took such terrible toll of the timber resources.

No State in the entire Union has a broader or more comprehensive plan of highway building than the Keystone Commonwealth. Under a law passed eight years ago, 7,500 miles of highway were taken over, and recently a fifty-million-dollar bond issue was authorized. With local and Federal contributions, the amount to be spent will reach the enormous total of $125,000,000.

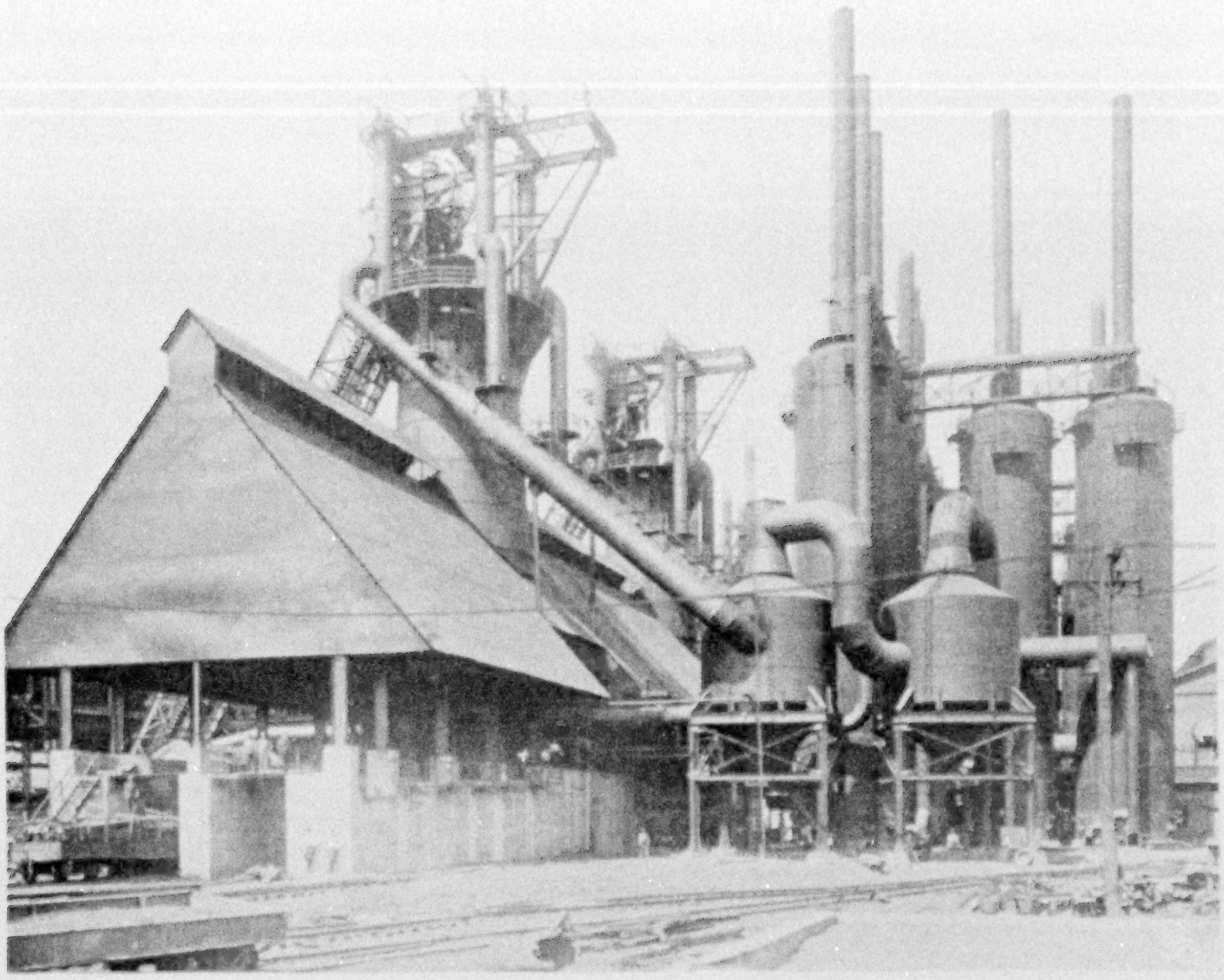
Under the plan now in force some three hundred routes are marked for improvement. These include the main highways between county seats, those joining the State roads of adjoining States, and those connecting principal cities and towns. They are under State rather than local jurisdiction.

In addition to bearing the entire burden of the construction and maintenance of intercounty and interstate highways, the State will furnish the counties with half the funds for improvement of local roads.

One who travels over such splendid highways as the new concrete road from Easton to Allentown will not fail to appreciate the Keystone State's splendid good-roads policy.

A NEEDED REFORM IN TEACHERS' PAY

The State authorities admit that the elementary educational system is not the best in the Union, and that there are many things that need to be done to bring its schools up to the highest standard; but the Governor and the Legislature are addressing themselves to the problem and propose to solve it.



A BLAST FURNACE OF TODAY AT SOUTH BETHLEHEM

Although the area of Pennsylvania is only one one-thousandth of the earth's land surface and only one-half of one per cent of the inhabitants of the globe reside within its borders, it produces one-sixth of the world's pig iron and one-sixth of its coal.

Adequate pay for school teachers is one of the first items in the program. One can scarcely realize that there are in such a progressive State more than eleven thousand teachers receiving salaries of less than $500 a year—a sum that even an unskilled laborer would turn up his nose at today.

These teachers are pursuing a calling second in dignity and in usefulness to none. They are influential factors in the intellectual development of the future citizens of the State, and cannot but be handicapped in their work by the less-than-living wage they have been receiving.

Pennsylvania is joining the ranks of those States which realize what a debt American civilization owes to the faithful, overworked, and underpaid school teacher, and which understand that no investment can be made that will yield greater returns than the voting of living salaries for instructors.

In the realm of higher education, no State is better equipped nor has more vigorous institutions. The University of Pennsylvania has an enrollment of some 5,000 students, most of them from the State, but with a minority drawn from all of the other States and from some fifty foreign countries. It has 30,000 living alumni. The University of Pittsburgh possesses a department of industrial research and is one of the country's foremost engineering institutions. The Pennsylvania State College was once called "The Farmers' High School." Now it is a modern collegiate institution, with schools of agriculture, engineering, liberal arts, and natural science.

Lehigh University and Swarthmore both have famous engineering schools. Then there are Bucknell, Dickinson, La-

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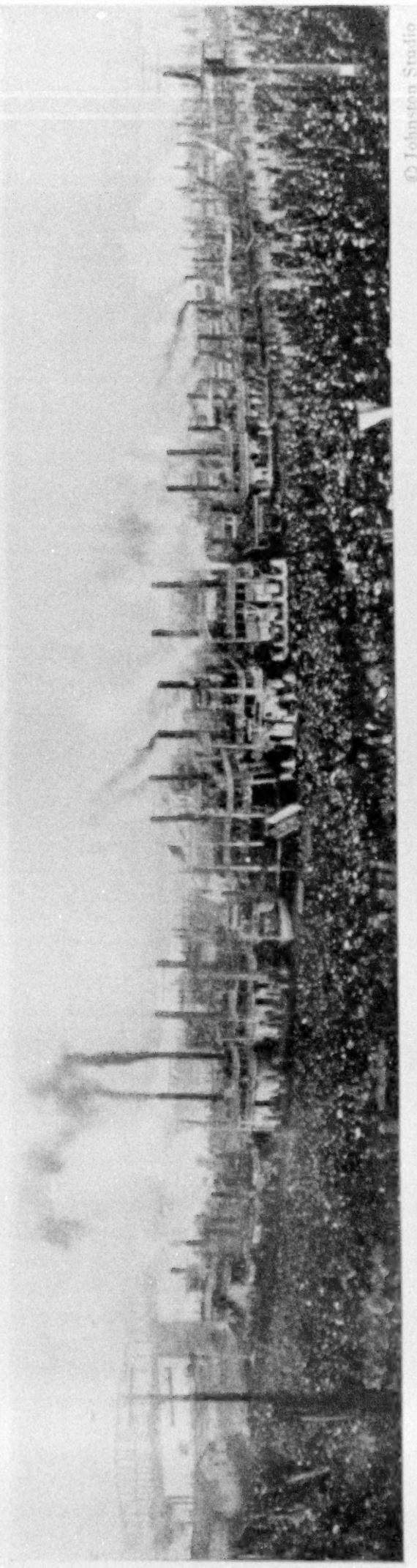

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CENTENNIAL CELEBRATION OF STEAMSHIP NAVIGATION ON INLAND WATERS, PITTSBURGH

While Pennsylvania has no seaboard, in the narrowly literal sense, its Lake Erie front gives it cheap water-freight connection with the Middle West; the Ohio and Mississippi provide an invaluable waterway to the Gulf of Mexico, and the Delaware River is the State's majestic gateway to transatlantic trade (see page 373).

fayette, Bryn Mawr, Franklin and Marshall, Washington and Jefferson, and many other institutions which have given many brilliant men and women to the nation. The Carnegie Technical School of Pittsburgh, with its elaborate engineering laboratories; the Drexel Institute of Philadelphia, with its fine course in the textile art, and Girard College, where an orphan boy is "mothered" and in due course sent out into the world with a college education in his head, a kit of tools on his back, and a "grub stake" in his pocket, are types of special schools of which there are a number in the State.

PENNSYLVANIA'S SHARE IN TWO GREAT INDUSTRIES

There is no part of the story of Pennland that is more striking or of greater significance than that relating to its industries. Modern civilization is based primarily on coal and iron. They enter into every truss and brace, every doorpost and cornice—indeed, into every element of foundation and superstructure of the edifice of human progress—for man has been able to rise from his primitive situation only as he has utilized them.

In the year that George Washington laid down the cares of life, the world was using per capita less than a bushel of coal and less than three pounds of iron, per annum. In the year before the Hun undertook his ill-fated program of making the whole earth his own, the average human being that inhabits the earth, whether South Sea cannibal or American business man, could claim four-fifths of a ton of coal and nearly ninety pounds of iron as his share of the world's output.

The story of Pennsylvania without an account of her share in these two great industries would be like Hamlet with the central figure forgotten. However, both have been so ably described in previous numbers of THE GEOGRAPHIC (see "Steel—Industry's Greatest Asset" and "Coal—Ally of American Industry," in the August, 1917, and November, 1918, numbers of THE NATIONAL GEOGRAPHIC MAGAZINE), that they are merely referred to, not described, here.

Another industry in which Pennsylvania was a pioneer is the manufacture of Portland cement. With the age of con-

Photograph courtesy Philadelphia Commercial Museum

TOBACCO FARM, LANCASTER COUNTY, PENNSYLVANIA

It is a familiar sight in this section of the State to see an old-fashioned "Amish" Mennonite, with his broad-brimmed hat and his "monkey-jacket" coat, contentedly puffing a big black cigar. He may "crucify the flesh" in his clothes, but he surely knows how to enjoy and produce a good smoke. In no Commonwealth of the Union is the versatility of industries or the variety of its people's interests greater than in Pennsylvania. Through farm and factory the same inspiring story of progress runs.

crete upon us, with buildings, bridges, lighthouses, telegraph poles, railroad ties, even ships, fashioned from artificial stone, that industry is proving one of inestimable value to the people. Millions of trees have been spared because of concrete, and thousands of acres of fine forest have been saved from the ravages of the sawmills because structures which formerly were built entirely of wood can today be erected without it.

THE STORY OF CEMENT IN PENNSYLVANIA

It is only a little more than half a century since all America's Portland cement came from across the seas—and comparatively little of it was imported for building purposes. This did not suit the ambitions of certain progressive Pennsylvanians in the Lehigh Valley, who decided to build their own kilns, and soon began to produce a cement that equalled the best that could be imported from abroad.

They found cement rock throughout a broad area in eastern Pennsylvania, of which the Lehigh district—above Allentown—is the center. To make Portland cement—which, by the way, derived its name from the fact that it resembles the English Portland limestone in color—alumina, silica, and calcium must be combined and prepared in a way that the finished product will "set" according to specifications. Clay, quartz, and lime in this district are the sources of these ingredients, although blast-furnace slag and other materials are used in some localities. In the valley of the Lehigh River from Siegfried to Easton are great beds

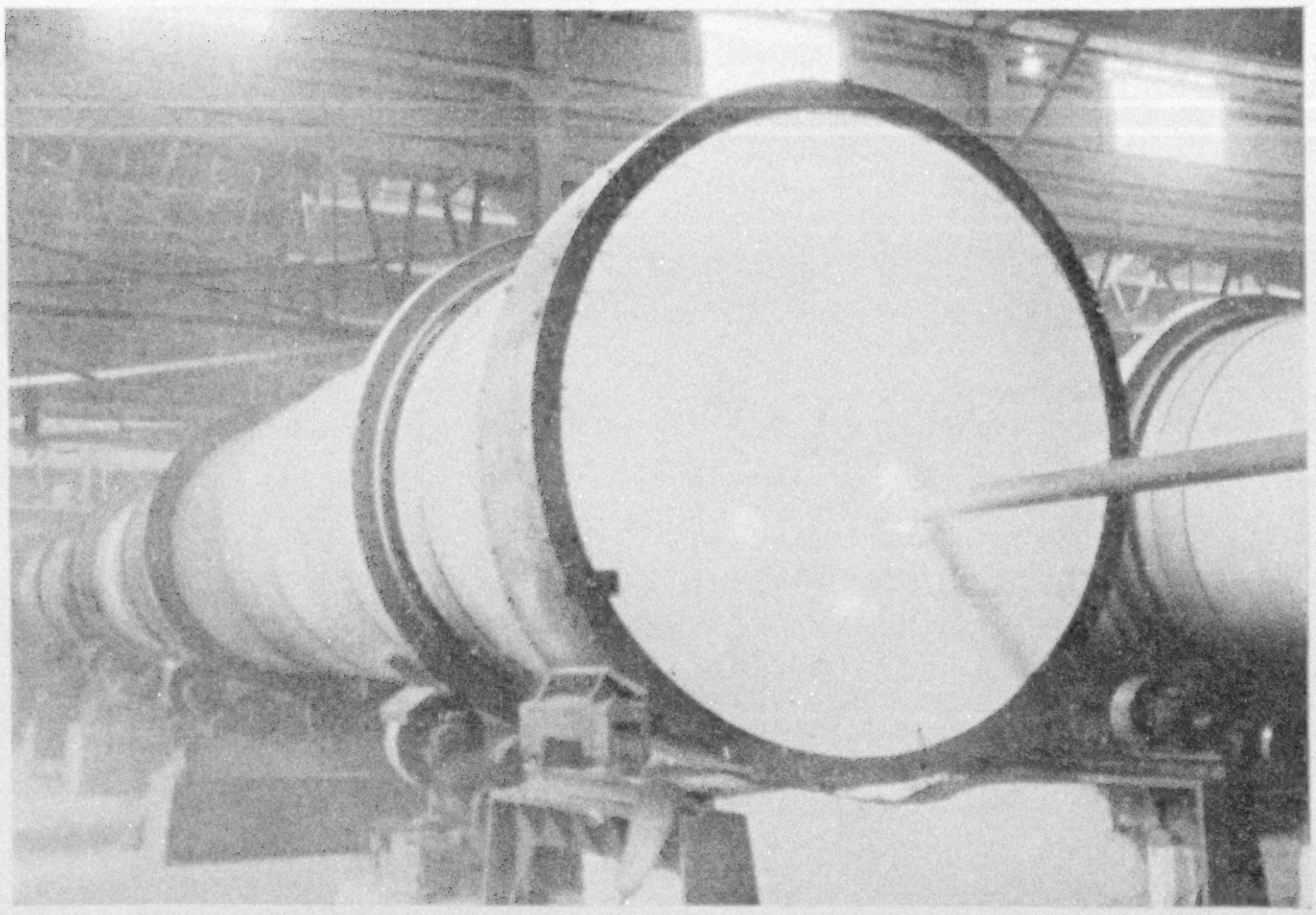
Photograph by William H. Rau

WISSAHICKON CREEK AT VALLEY GREEN: FAIRMOUNT PARK, PHILADELPHIA

With its more than 3,000 acres, Fairmount is one of the largest city parks in the world and is Philadelphia's special pride. It extends along both banks of the Schuylkill River for a distance of four miles. Skirting the picturesque Wissahickon Creek, which flows into the Schuylkill, is the famous Wissahickon Drive.

of rocks, some strata pure limestone and others clayey or argillaceous limestone.

These two kinds of rock are mixed in proper proportions and ground to impalpable powder. Huge crushing machines munch hungrily their diet of stone, day in and day out, passing their grist on down to giant grinders having maws filled with steel flails that fly around at high speed, propelled by a central shaft; and



A ROTARY CEMENT KILN

The powdered coal is introduced into the kiln through the pipe in the end. The glowing spot below is the opening through which, after having donned green goggles, one looks at the inferno within.

when they digest their quota of cement rock that substance looks like flour that has turned dark gray.

While the rock crushers and grinders are busy—whole batteries of them—the coal crushers and grinders are at work also, preparing coal dust as finely ground and impalpable as the rock dust.

THE ROTARY CEMENT KILN

Here another process begins, in which long rows of rotary kilns play an important rôle. Imagine a hollow pipe, lined with fire-brick, big enough for a horse to walk through, about 150 feet long, mounted on pivots and rotated by cog gears after the fashion of a great shaft. Into one end pours a constant stream of rock dust. Into the other, driven madly forward by compressed air, goes a like stream of coal dust, hissing and burning, as from an inferno. In the middle of the big kiln they meet.

The observer is supplied with a pair of colored glasses; the operator opens a tiny door and bids you look in. Glowing with a whiteness that rivals the electric arc, you see the materials apparently in the process of turning from solid to liquid; but, just at the point of incipient fusion, droplets or nodules of a dark-gray color, ranging from the size of a small pea to that of a large hazelnut, are formed.

These nodules are carried out on an endless-bucket belt, glowing like embers on a hearthstone, to the cooling towers. Here they are cooled under forced drafts of cold air. Then they go to meet another set of grinders, to endure the beatings of another series of mechanical flails. Literally they are beaten to dust—and that dust is the Portland cement of commerce, to which the world's debt cannot be estimated with any yardstick at my command.

THE SCIENCE OF HANDLING DUST WITHOUT WASTE

The finished product is carried to large storage bins and then barreled or bagged.

Photograph by J. Horgan, Jr.

ONE OF A THOUSAND MONUMENTS TO THE COAL MINER; THESE MOUNTAINS OF REFUSE FORM A CONSPICUOUS PART OF THE LANDSCAPE OF THE ANTHRACITE AREA; NEAR SCRANTON

When it is realized that this great culm bank is only the tailings of the anthracite industry, and that wherever one goes, from Carbondale to Pottsville, and from Shickshinny and Shamokin to Mauch Chunk, replicas of it, large and small, may be seen, something of the immense demand the country has made on the hard-coal mines can be appreciated.

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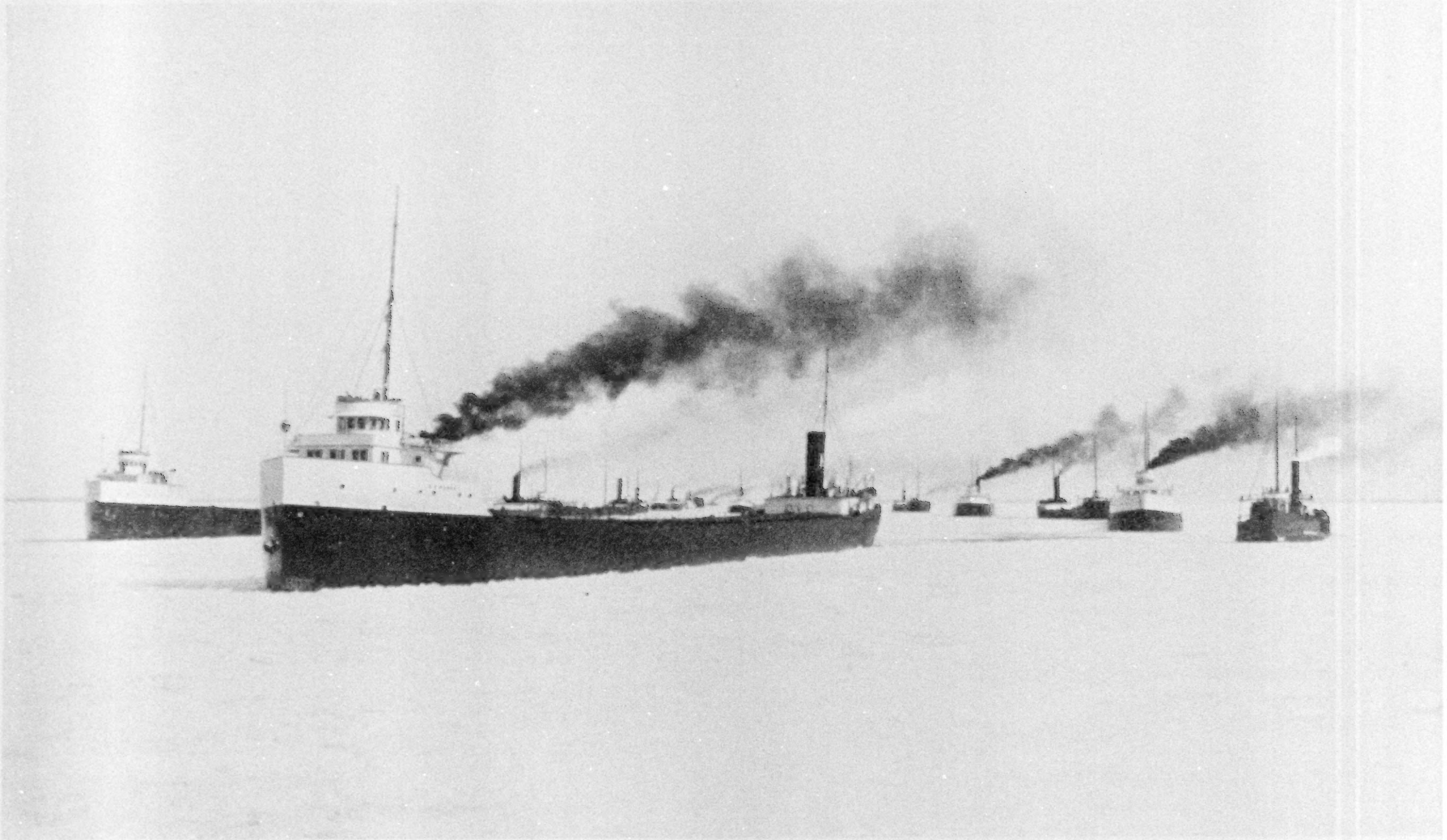


Photograph by A. E. Young

THIS STRING OF ORE VESSELS, MILES IN LENGTH, IS HELD FAST IN THE ICE ON LAKE ERIE

What could more eloquently picture the greedy appetites of Pennsylvania's blast furnaces than this involuntary congress of cargo carriers! When surveys showed that the southern boundary of New York did not reach the shores of Lake Erie, and Connecticut and Massachusetts set up claims for the little triangle that did not belong either to New York or Pennsylvania, the United States Government cut the Gordian knot by taking possession and selling it to Pennsylvania—thus preceding the Paris Peace Conference a century and a quarter in the consideration of "a corridor to the sea" (see page 403).

THOUSANDS OF TONS OF ORE STORED IN A JOHNSTOWN YARD

Nestling in a narrow valley on the western side of the Allegheny Mountains, Johnstown is a typical "steel town." In the doleful days of the Johnstown flood, the people lost all but their courage— the tap-root of their city's present splendid standing.

town flood, the people lost all but their courage— the tap-root of their city's present splendid standing.

Photograph courtesy Philadelphia Commercial Museum

THE HOLD OF A LAKE STEAMER WHICH BRINGS THE ORE FROM THE MINES OF MINNESOTA TO THE STEEL INDUSTRY OF PENNLAND

The huge buckets can scoop up two 4-horse wagon-loads of ore at a time.

In some plants the packing machinery is far from the least interesting part of the equipment. Leading from the bin is a large hopper with an automatic weighing machine. The barrel, with the head in place, but having a two or three-inch hole in the center, is put in position, a big funnel connecting the head-bung with the hopper. Through this the cement flows until both the barrel and the funnel are full.

The barrel is then lifted away by a machine and set on a mechanism that may be depended on to pack the cement tight. Overhead is a shaft made on the principle of that which drives the pistons of an automobile engine. As it turns around, it lifts the barrel several inches, and then lets it drop, repeating the process about as rapidly as one can count. When this shaking process is finished all of the cement has been driven out of the funnel and into the barrel, which is now packed as tightly as if it were solid rock. A piece of wood is nailed over the hole, and the steel-hooped barrel, weighing nearly four hundred pounds, is ready to be transported.

With three separate operations of converting hard solids of considerable size into dust, at the rate of thousands of barrels a day, one would naturally think of a cement plant as the dustiest place in all the world. Yet in many modern Portland cement plants there is not as much free dust floating around as one finds in the average old-fashioned country gristmill. Indeed, there are some plants so free from dust that one might go through them in a dress suit and come out without serious need of a whisk-broom or a clothes-brush.

The shearing strength of concrete made from Portland cement is rising to such unexpected heights that the experts suggest that the day may not be far distant when architectural specifications will permit the same lightness of construction that is accepted with steel. A world shortage of steel might be compensated

INTERIOR VIEW OF ONE OF THE LARGE SILK MILLS AT WILKES-BARRE

A pound of raw silk often contains enough unspun thread to reach 181 miles. To convert this into a pound of organzine, or warp threads, requires 264,000,000 turns of a spindle—10,000 a minute for two months' working time.

by an abundance of artificial stone as hard as any adamant made in the laboratory of Nature.

THE ROMANCE OF SILK

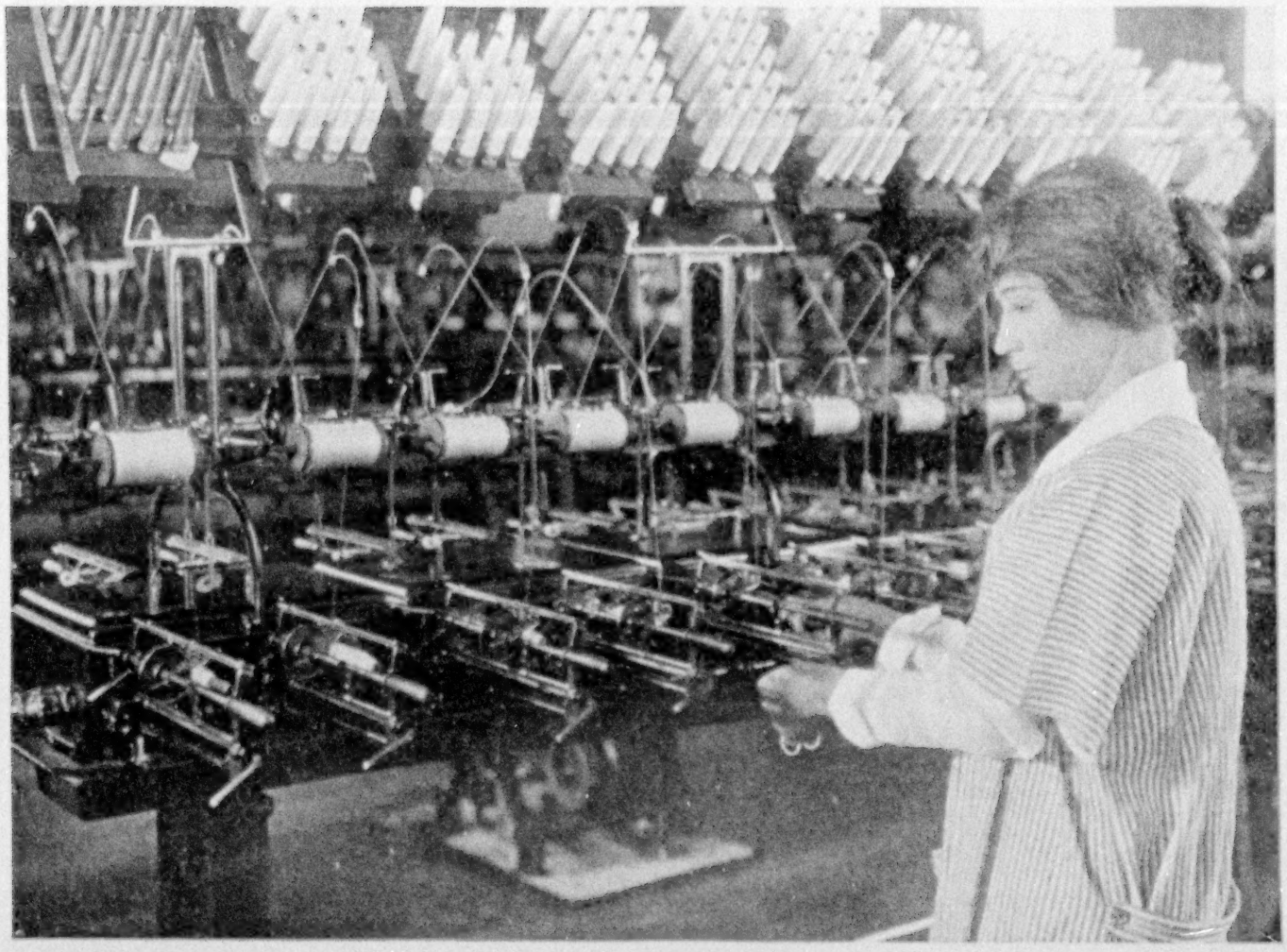
It is a long step from cement to silk, and yet, as showing the remarkable versatility of the industrial situation in the Keystone State, a step worth the taking here. There are several good reasons why Pennsylvania produces one-third of all the silk made in America. In the first place, silk manufacture is essentially a woman's industry. A woman can attend a loom as well as a man, or look after spindles, or supervise the quilling of thread.

Nowhere else can such an abundance of women workers be found as in the coal regions and the heavy manufacturing districts. Such industries are largely closed to women, and hence the wives and daughters of the miners and factory workers welcome employment in silk mills.

Then, again, the silk that milady wears may seem filmy and its sheen may be charming, but the process of manufacture demands a surprising amount of power. Especially is this true of the spinning, or "throwing," as it is technically known. Raw silk is too thin to be woven directly. The spun silk that constitutes the warp, or threads that run lengthwise of the goods, is known as organzine.

THE POWER REQUIRED IN MAKING SILK

A pound of good quality raw silk will yield enough unspun thread to reach from Philadelphia to New York and return—181 miles; yet in making organzine, or warp thread, every inch of that must be twisted some sixteen turns, after which it is doubled and twisted about fourteen



WINDING SILK ON QUILLS IN A MODERN MILL

The hundreds of spools of white silk thread shown at the top of the picture have been wound by the machine which the operator is tending. These spools, or quills, are now ready for the shuttle and the loom (see illustration on page 390). The American silk industry employs more than a hundred thousand operatives in converting annually 25,000,000 pounds of raw silk into a finished product.

turns in the reverse direction, the exact number of turns depending upon the use to be made of the thread.

The two twistings are equal to twenty-three turns for every inch of the original thread, so that the revolutions of a spindle required to convert a single pound of raw silk into a pound of organzine reaches the enormous total of 264,000,000. In other words, if the conversion had to be made by a single spindle, it would have to do ten thousand turns a minute, fifty-five hours a week, for eight weeks or lose its union card!

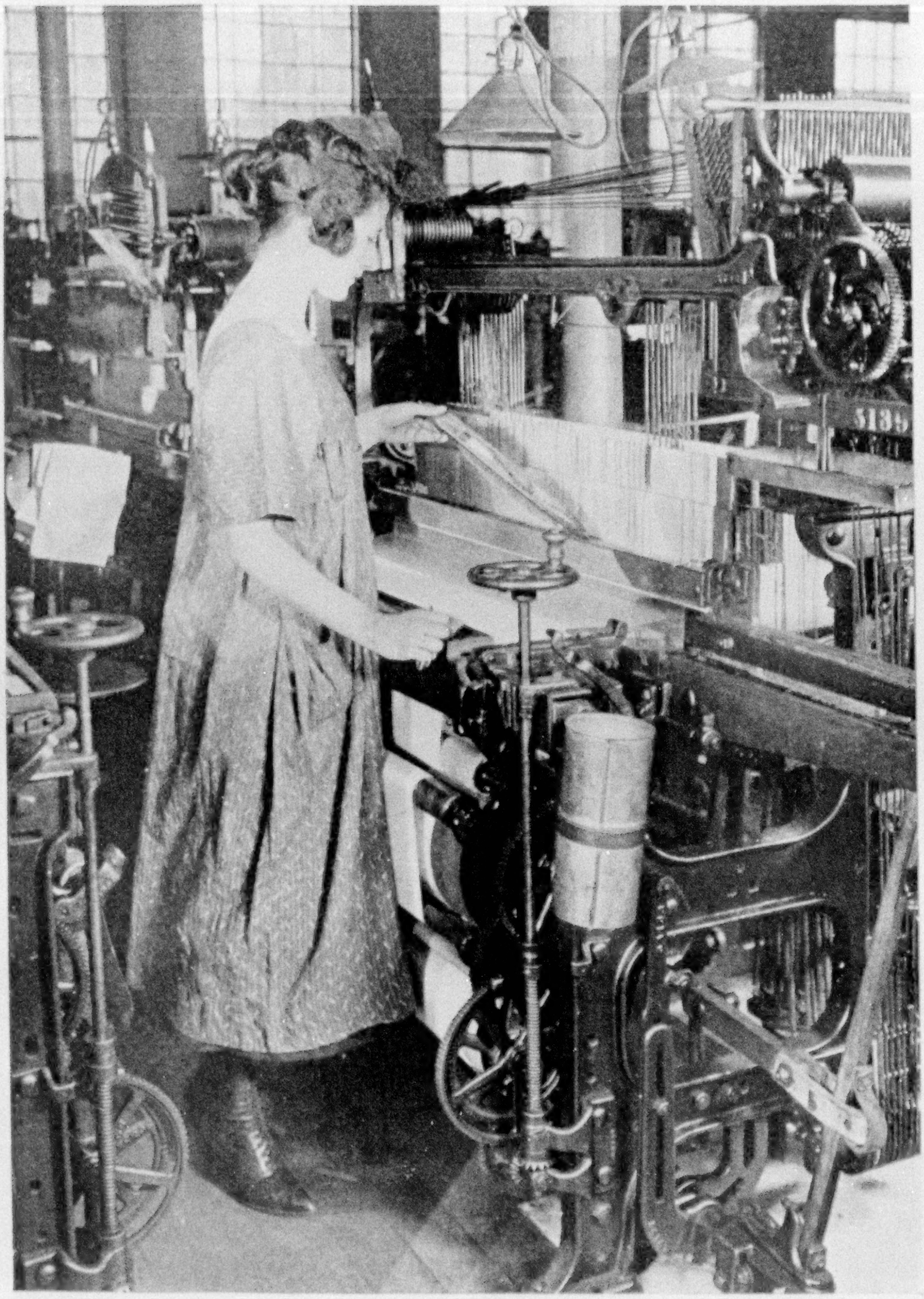
What happens in the case of the warp threads takes place in less degree in the woof threads—the ones that run across the goods—which are known as tram, and have only a single spinning.

After such facts as these, any one can readily see that a great deal of power is needed in the making of even such delicate material as silk. They explain why such a large percentage of the silk woven in America is prepared for the weaver in the coal region around Wilkes-Barre, Hazleton, and Scranton. Cheap fuel means cheap power, and cheap power makes silk throwing profitable.

The throwing and dyeing are usually done for the weavers on a commission basis. The raw silk, as it comes from Japan, China, or Italy, is first steamed and degummed. This gum takes away about one-fifth of its weight. After this come the dyeing and throwing, and usually the weighting.

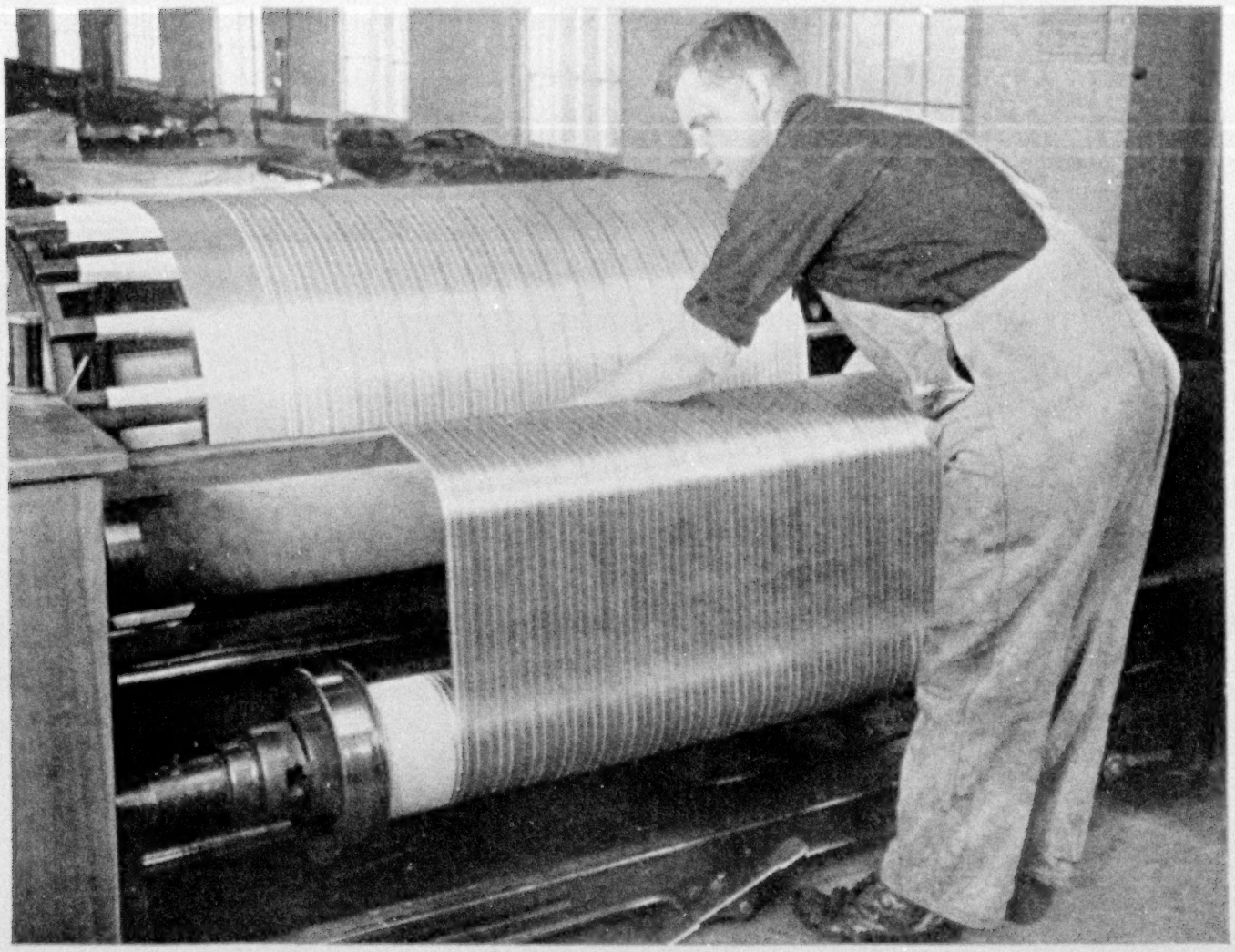
WOMEN ARMORED WITH TIN

The weighting process is very interesting, both from the standpoint of manufacture and wearing. In silk that may have cost eight or ten dollars a pound, the extraction of the gum represents a



WEAVING SILK ON A MODERN LOOM

The girl in the picture is holding up for inspection the shuttle which passes back and forth as the warp threads are separated to make proper paths for it—above one thread, below the next, etc., the number and order of the threads depressed and elevated depending on the character of the goods being woven.



BEAMING, OR PREPARING THE WARP FOR THE LOOM IN SILK WEAVING

This is composed of the threads that run lengthwise of the goods. It is put on the loom where the shuttles carry the woof threads back and forth and complete the weaving process.

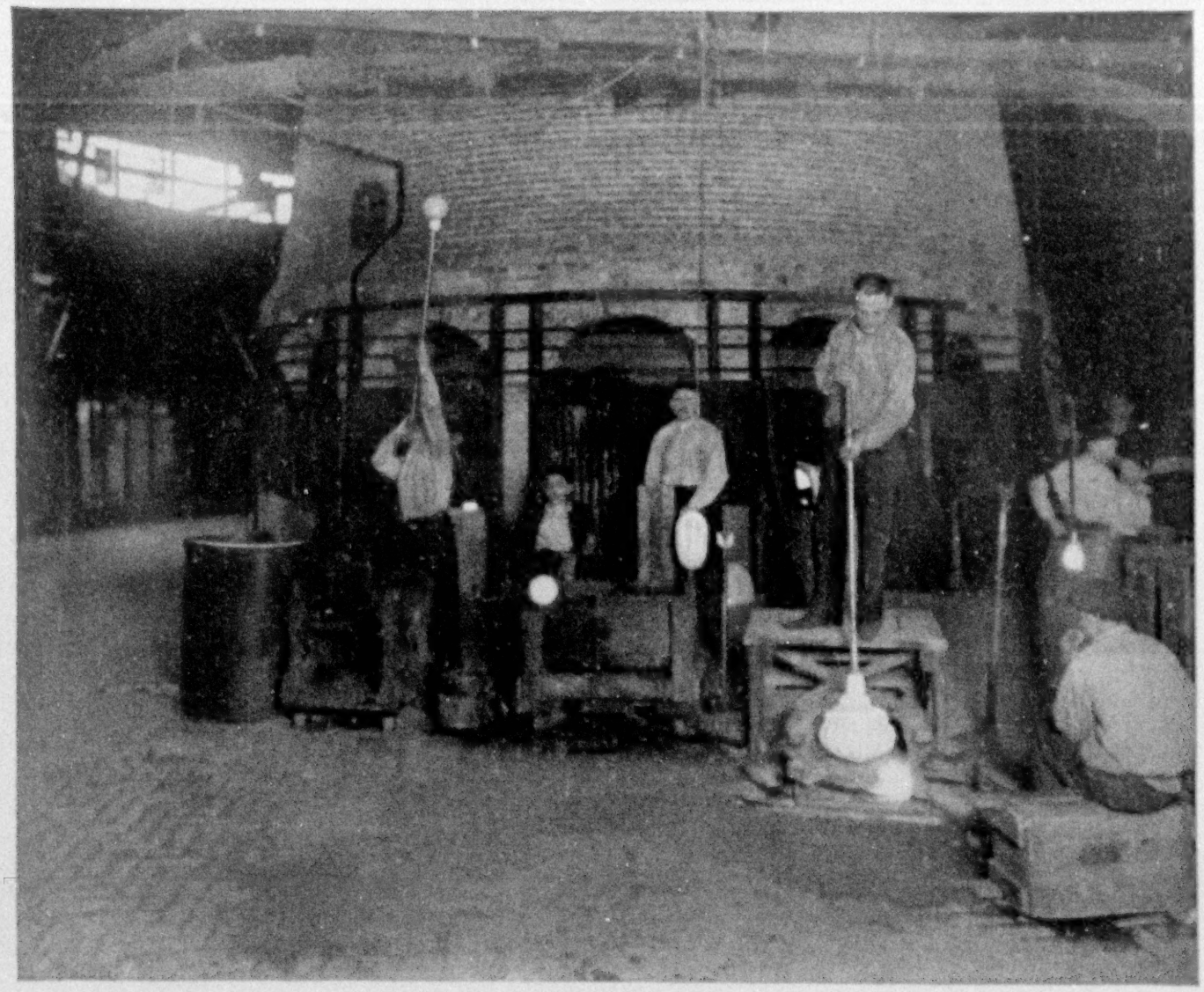
serious shrinkage. It happens that silk has a particular affinity for tin dissolved in hydrochloric acid. So the silk manufacturer proceeds to treat his degummed silk to a bath of liquid tin. It absorbs several ounces to the pound of silk. Then he washes it in a phosphate-of-soda preparation which increases its power of absorbing tin, and gives it another bath. He may repeat the process until his pound of raw silk, which had shrunk to thirteen ounces by the degumming operation, takes on enough tin to make it weigh at least twenty and perhaps forty or even sixty ounces.

This weighting is of advantage to the wearers. An ordinary 19-inch taffeta, that retails at, say, $1.50 a yard, is composed, probably, of five-eighths silk and three-eighths tin. Yet it is satisfactory in its luster and will ordinarily wear for two seasons, which is alleged to be the longest any woman would want a silk dress or waist to last. If that taffeta were made from untinned silk it would cost $2.20 a yard and serve milady no better.

During the last year or two, under the stress of raw silk prices of unprecedented heights, weighting came to be done in the woven goods as well as in the tram and organzine, so that the women of the country often wear as much tin as silk, and frequently more.

CIVILIZATION'S PROGRESS MEASURED IN GLASS

To say that civilization's advancement is based on glass seems a gross exaggeration at first blush; and yet, when one reflects how many sciences and how much human knowledge came to the race through that commodity, the accuracy of the statement is apparent. The science of preventive medicine was born of the microscope. But for the telescope and the spectroscope the world would know about as much of astronomy as was known by the shepherds on the plains of Persia. One may read the whole list of technological industries without discovering lines of



GLASS-BLOWING AT A PENNSYLVANIA PLANT

In this picture are shown most of the operations of blowing glass by hand methods. The first man on the left of the picture is the "blower." The glass has been gathered on the end of the blowpipe for him and he is shaping it. The next workman is cooling the shaped ball. More glass is then gathered on the ball and the third workman is enlarging it. The fourth workman is the final blower. Standing on the "blower's block," he blows the glass until it assumes the shape of the mold inside the block. The making of window glass by hand methods is a variation of the process shown (see text, page 395).

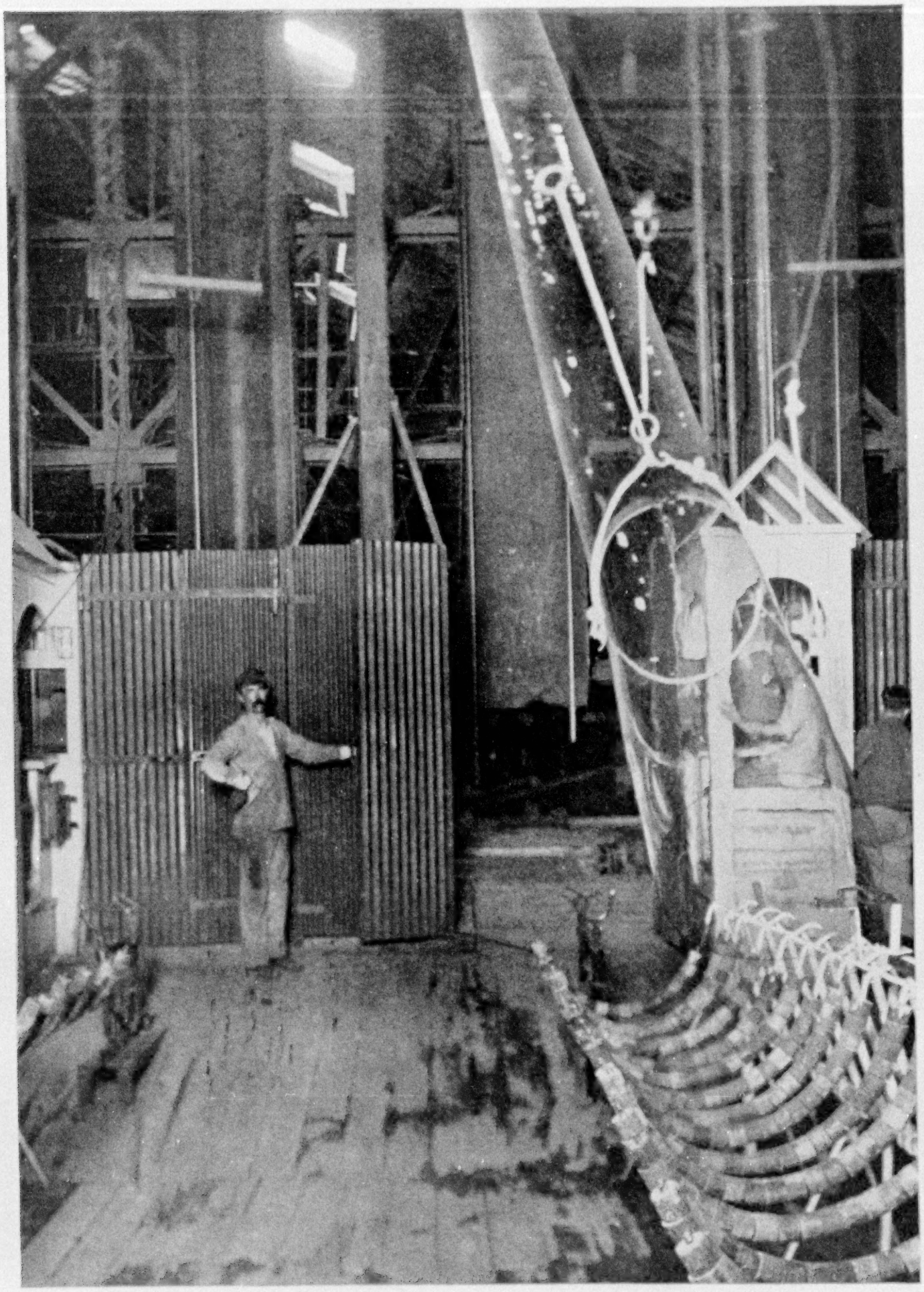
endeavor where glass does not play an essential rôle.

It was Pennsylvania that fostered the manufacture of this commodity in America, and it is from Pennsylvania today that the American people get a third of their supply.

The processes of manufacturing glass are extremely interesting. To see sand, soda, and lime mixed, subjected to heat, and turned into glass as transparent as the clearest water, or even as the very air itself, shows what liberties man has learned to take with Nature. Now as free-flowing as water, now as sticky as warm taffy, now as hard as flint, it lends itself to the manipulation of human hands and the purposes of man with astonishing versatility.

The mixed materials, technically known as the "batch," consist of white sand and such bases as potash, soda, lime, and lead. Small quantities of other materials are added as auxiliaries to change the color or nature of the glass. Manganese and arsenic are among the agents employed to make it colorless. For window glass a batch may be made up of 8,000 parts sand, 2,200 of soda sulphate, 2,500 of lime, 50 of arsenic, and 40 of powdered coal; or the amount of lime may be cut down and carbonate of soda substituted.

Window glass is of two kinds—cast and blown. The cast is the plate-glass of commerce. In making it the process is not dissimilar to the rolling of dough on a dough-board. A huge flat table with a rim around the edge is filled with a pile



A MACHINE-BLOWN CYLINDER OF WINDOW GLASS BEING LOWERED INTO ITS CRADLE

Pennsylvania leads the United States in the production of glass in its various forms, and the great industrial city of Pittsburgh has been the scene of most of the developments in process and labor-saving machinery which have revolutionized this industry in the past two decades. The cylinder is hollow.

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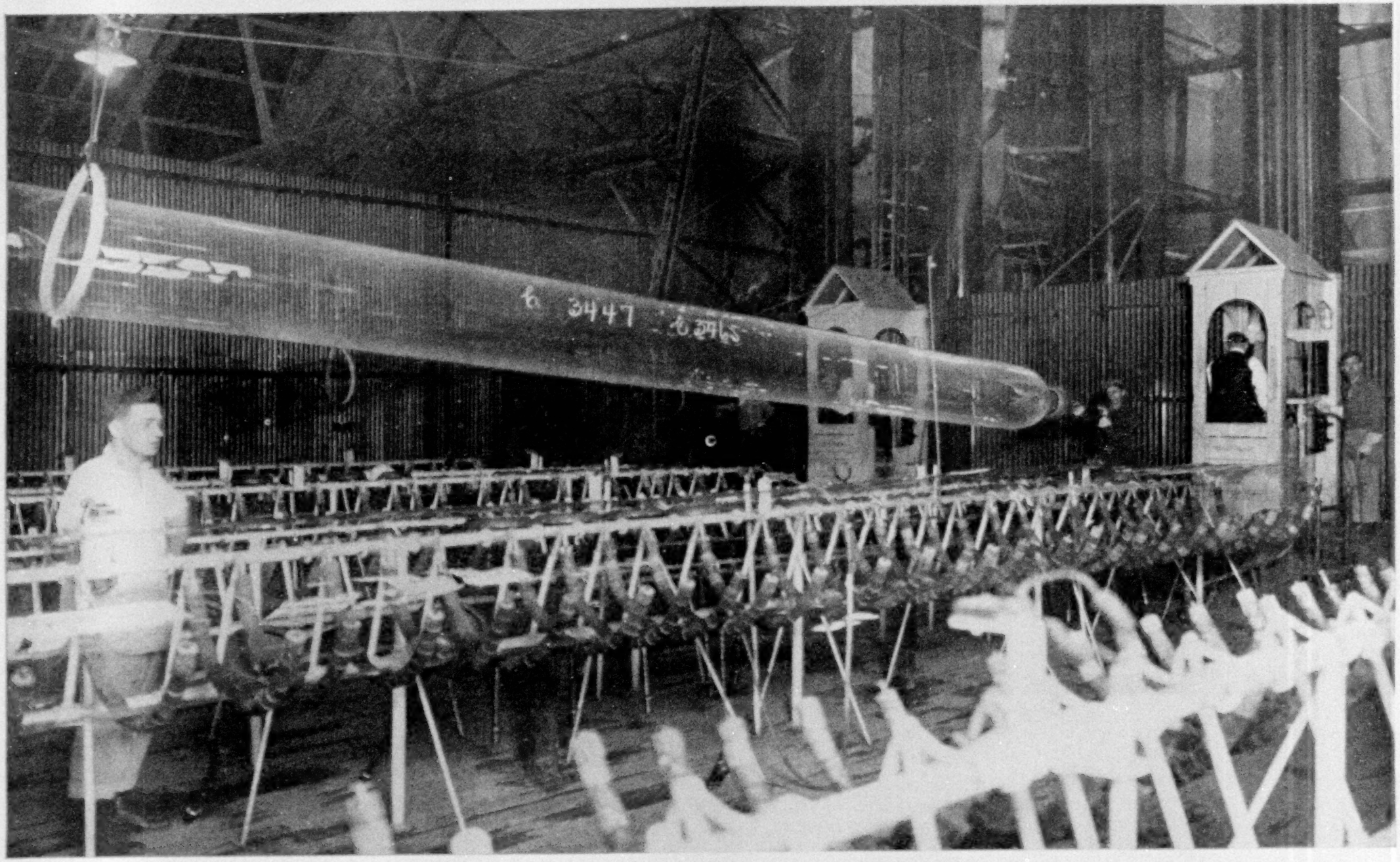
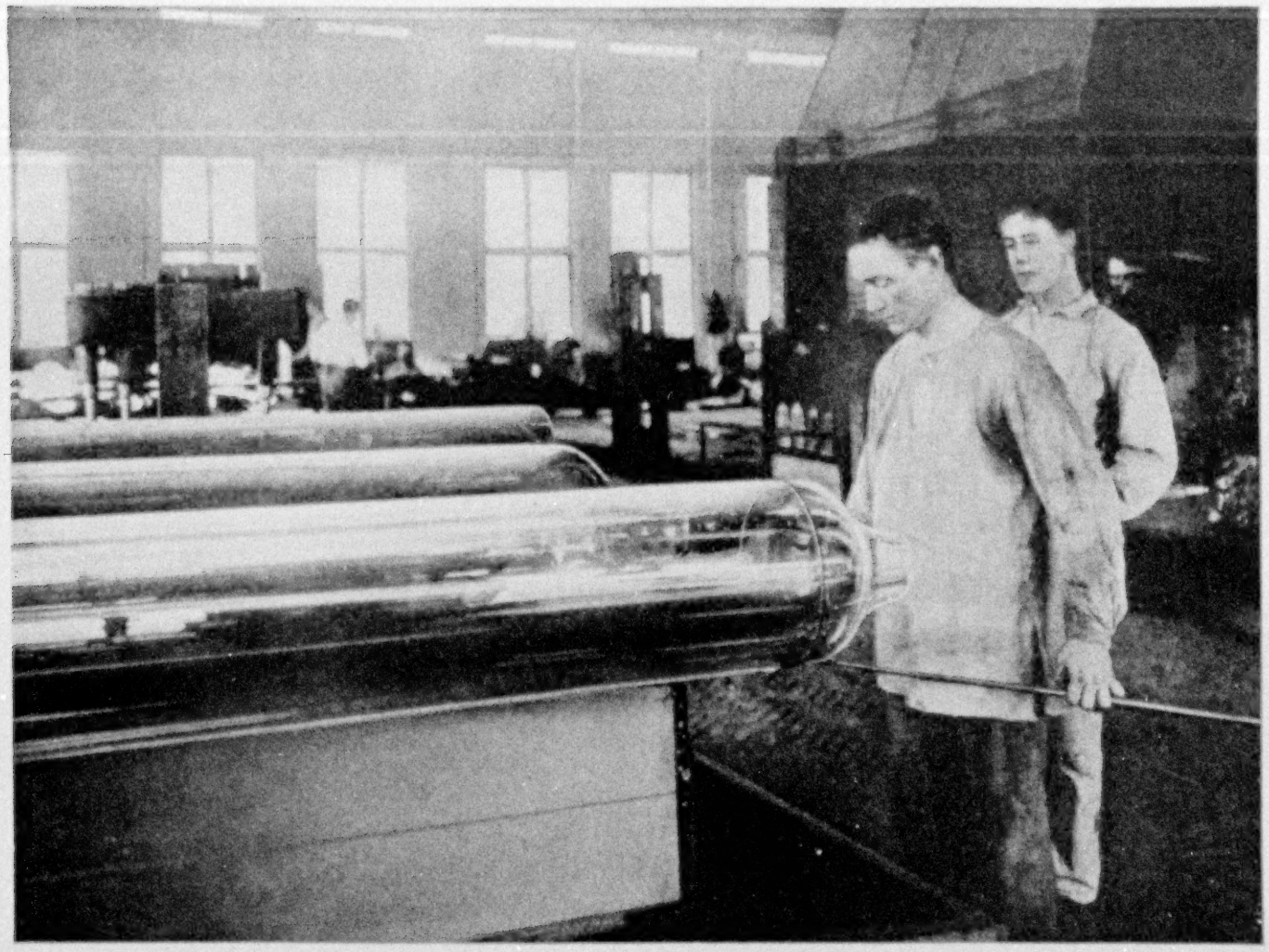


A MACHINE-BLOWN WINDOW-GLASS CYLINDER BEFORE THE ENDS HAVE BEEN REMOVED

In its present form it resembles a giant test-tube. After it has been lowered into its supporting cradle the ends will be removed by cracking the cylinder smoothly, this being accomplished by wrapping hot glass threads around the glass and then touching the surface with a cold iron (see page 395).



Photograph courtesy Philadelphia Commercial Museum

REMOVING THE WASTE ENDS OF CYLINDERS, ONE OF THE OPERATIONS IN THE MANUFACTURE OF WINDOW GLASS

A cylinder of glass having been blown to the proper thickness and length, both ends are snapped off. A hot iron or electric wire is then passed along one side from end to end. The application of a cold iron to this heated streak causes the glass to crack, after which the cylinder is ready to be softened by heat and flattened into sheet glass.

of hot, putty-thick glass. A big mechanical rolling pin spreads it out, after which it hardens. Then it is sent to the annealing furnace, heated, and allowed to cool gradually, for cooling either too fast or too slow would be ruinous. Finally it is ground down and polished and is ready for shipment.

FROM SOUP TO WINDOW GLASS

The process of making blown window glass is entirely different. In hand-blowing, after the batch has been melted, the "gatherer" takes a pipe about five feet long, with a bell-shaped head at one end and a mouthpiece at the other, and dips the bell-shaped end into the molten glass. A small ball of the glass adheres. He blows through the pipe and transforms this ball into a thick-skinned bubble. When this cools sufficiently it is dipped into the molten glass again, and more adheres. The process is usually repeated five times, the bubble growing thicker of skin each successive time (see page 392).

The pipe, with its adhering plastic bubble, is then given to a "snapper," or helper, who carries it to the "blower's block," where the "blower" takes it. The latter workman is the king bee of the glass industry—big of body, powerful of lung, and deft of hand. He places the bubble in the "block," which is an iron mold set in water to prevent its becoming too hot, and lined with charcoal to keep the iron from discoloring the glass.

By turning the bubble in the block, blowing air into it as he does so, and gradually drawing the pipe upward, he slowly transforms it into a pear-shaped affair. The lower part gradually becomes solid and too hard to be workable even with his powerful lungs. The snapper puts it into the blow furnace, and

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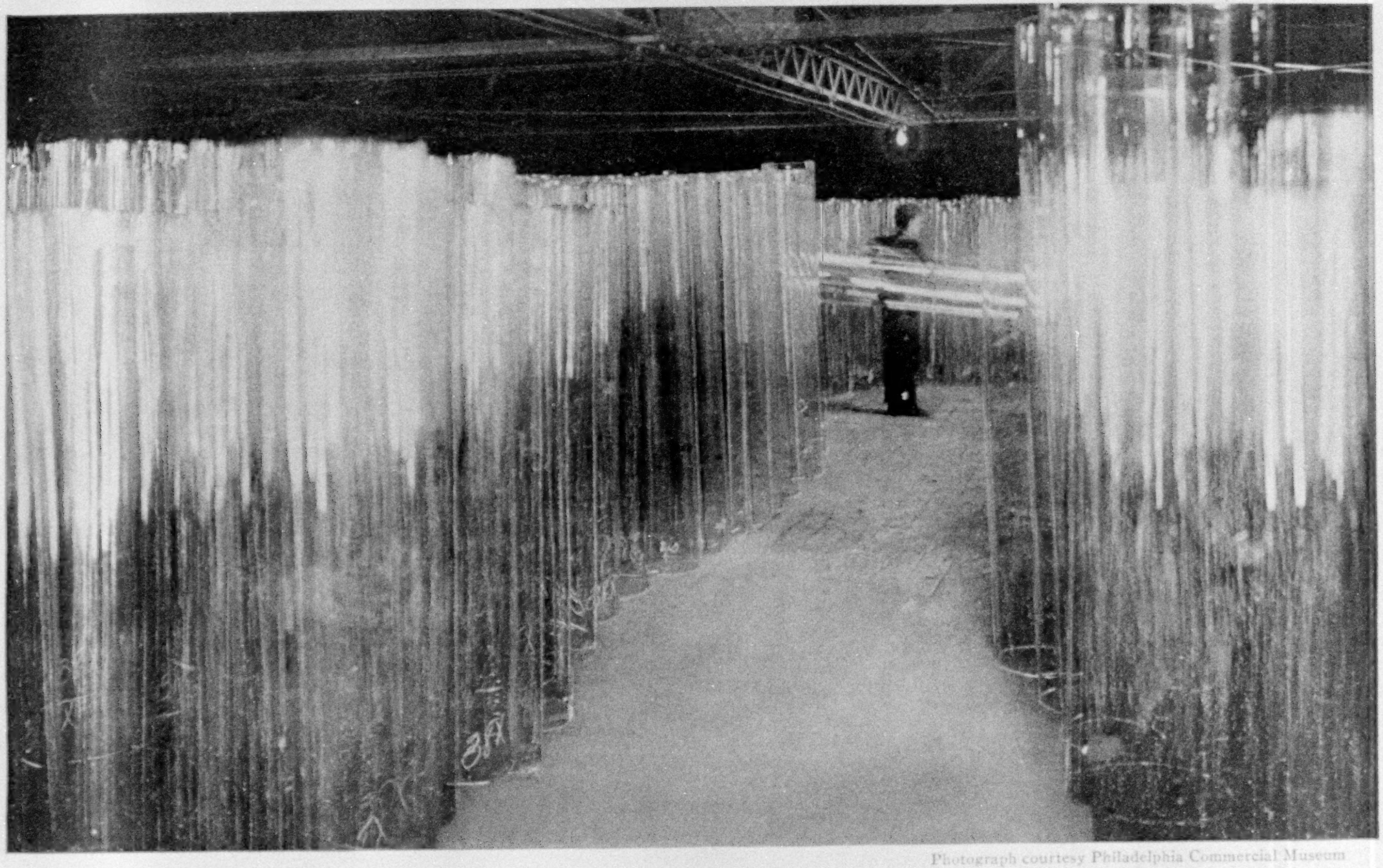

Photograph courtesy Philadelphia Commercial Museum

WINDOW GLASS IN UNCUT CYLINDERS STORED FOR FLATTENING

When window glass has been blown and the defective ends cut off, it has the shape of glass tubing about as tall as a man and with a diameter of about twenty inches. How this tubing is split and made flat is explained in the text on page 397.

when it is properly heated he gives it back to the blower. Standing over the "swing hole," the blower allows the weight of the plastic glass to elongate the pear into a cylinder, which he gives the desired diameter by blowing into it intermittently.

But, although it has reached the desired diameter, the cylinder is not yet long enough to suit his purpose. So he reheats it and blows it over and over again until it attains the prescribed length.

At this stage the cylinder is completed, but the free end is closed and the other end still adheres to the blowpipe. It is put back into the blow furnace and the free end heated until it is soft enough to permit the blowing of a hole through it. The resulting imperfect end is cut away by wrapping a hot glass thread around the cylinder above the imperfection, at the point of severance. Touched with a piece of cold iron, the imperfect section breaks asunder. The cylinder is freed from the blowpipe in a similar manner.

We now have a perfect hollow cylinder of regulation window glass. But before it can be used in a window it must be flattened. To accomplish this it must first be split open. A hot iron or a charged electric wire, passed up and down the line of cleavage, plays the rôle of a pair of shears. It causes a strain-line to form from one end of the cylinder to the other, and when this is touched with a piece of cold iron the big roll breaks open as perfectly as though it were cut open with a diamond cutter and straight-edge.

After this the roll of glass is sent to the annealing furnace. Heated to a proper degree, the glass becomes soft enough to permit the roll to be flattened. It is then carefully cooled and stored, ready for market.

MECHANICAL GENIUS A REVOLUTIONIZER

By the hand-blowing process cylinders up to as much as six feet long and nineteen inches in diameter can be blown. Machine blowers have been gradually substituted and have revolutionized the art of making flat glass. All the larger cylinders, such as are illustrated on pages 393 and 394, are machine blown.

In simple terms a machine blower is an apparatus which automatically dips a big pipe into a kettle of molten glass, and then gradually raises it, pulling all the molten glass upward as the pipe rises. A constant stream of air kept flowing in through the pipe causes the glass to assume the form of a cylinder. Dip a soda straw into a thimbleful of molasses, and blow through the straw as you lift it up from the molasses—that process would roughly duplicate the principle of the mechanical glass blower.

It would be too long a story to tell in this article the processes of making all kinds of glass; but it may be said that when the machine for blowing bottles came into use it changed the bottle industry as much as the mechanical blower changed the window-glass industry. Machines have been invented for blowing electric lamp bulbs also, but the hand blowers are still able to produce a major portion of these.

When America went to war, there was a dearth of optical glass in the country. Germany had a monopoly thereon; but Pennsylvania glass experts and the United States Bureau of Standards set to work on the problem, and today this State is making as good optical glass as is to be found anywhere. Hereafter America will see the world through its own spectacles and not through glass that comes from overseas.

One of the demands of the war was for one-way glass,—glass that is transparent from one side and opaque from the other—being required for range-finders and other optical instruments. It is made by silvering one side, so that it transmits exactly the same amount of light that it reflects. There is a possibility that such glass will ultimately be used in architecture. With it the manager of a big business could have an office where he could work in privacy and yet always be able to see what was going on in the outer offices.

One of the largest groups of factories in America is that which comprises the companies classified under the general head: Westinghouse industries. One of these mammoth plants fabricates the air-brake, to which the world owes a great debt. It has equipped some three million

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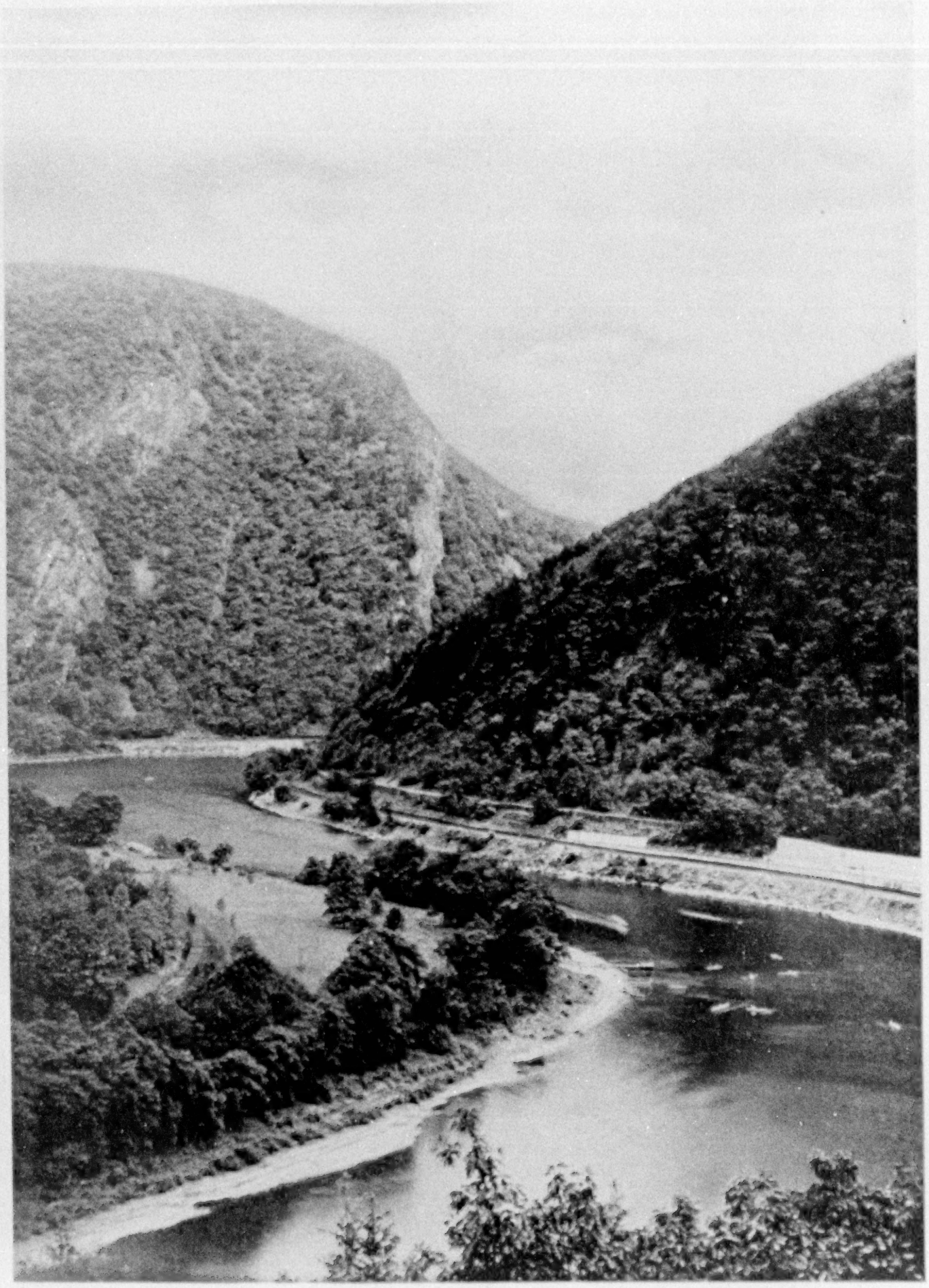

THE TORTUOUS TURNINGS OF DELAWARE WATER GAP

Wherever a Pennsylvania river breaks through a mountain barrier, there is a railroad to hug its banks. The streams are nature's engineers in constructing passages through the mountains, and man is quick to adapt such rights-of-way to his needs.

cars and perhaps a hundred thousand locomotives with this life-protecting boon. Another of the Westinghouse group makes the switch and signal equipment now in use on roadbed mileage sufficient to establish a ten-track line entirely around the earth. Still another is the giant electric machine company that creates everything electrical, from a sadiron to a dynamo of ten thousand horsepower.

A STATE OVERFLOWING WITH CITIES

No State in the American Union possesses so many thriving urban communities as Pennsylvania. With Philadelphia not far removed from the two-million mark in population, and Pittsburgh driving upward to the three-quarters of a million, both the east and west sections of the Commonwealth are possessors of industrial communities of first rank in the Western World. But as these two cities will later be the subjects of articles to appear in the "Cities of the Nation" series in THE GEOGRAPHIC (see "New York—Metropolis of Mankind," in the July, 1918, number, and "Chicago Today and Tomorrow," in the January, 1919, number), further reference will not be made to them here.

In addition to these, the State has two other cities that have passed the hundred thousand line, three that are in the seventy-thousand class, and two in the sixty-thousand class. It also has three with fifty-odd thousand people, the same number with forty-odd thousand, and a like number with thirty-odd thousand. Fourteen cities have passed their teens and have not reached their thirties, and thirty or more have outgrown four figures, but have not yet passed out of their teens.

SCRANTON, A HIVE OF INDUSTRY

Starting down the list after the Quaker City and the Smoky City, one comes to Scranton, situated in the heart of the anthracite region, in Lackawanna County.

Imagine buying power on the basis of two dollars a ton for buckwheat anthracite delivered at your furnace-room door. Fancy twenty million tons of black diamonds coming up out of the earth in one community every twelve months. Picture a people so progressive that they raise a community fund of a million dollars to be used in aiding responsible industries to expand. That's Scranton, and why it is growing at such a rapid rate.

One factory turns out three million buttons a day. One-third of the nation's raw silk is carded and spooled in its metropolitan district. More than half a million people live within twenty miles of its court-house. Bees in a hive in the springtime were never busier than the hustling, bustling, go-ahead folk of the Electric City.

Almost at Scranton's very doors are the famous Pocono Hills, the Delaware Water Gap, and the lakes of southern New York. A city of homes, public health is almost an obsession with its people, and a death rate of only thirteen per thousand is the result.

A CITY OF HOSIERY AND HARDWARE

Next in order of size comes Reading, the nation's second city in the production of hosiery and builders' hardware. With the anthracite region at its back door and the splendid farming communities of southeastern Pennsylvania to the right and the left and in front of it, the city is keeping pace with its larger neighbors in a way out of proportion to its size. It has more than five hundred manufacturing plants, which make commodities ranging from adding machines and railroad engines to spectacles and art glass. For the diversity of its manufactures, the prosperity of its people, the advantages of its location, and the promise of its future, Reading is an urban community that justifies the pride of its citizens.

Wilkes-Barre, built upon the beautiful banks of the Susquehanna, calls itself the "Diamond City." More than three hundred thousand people live within a radius of ten miles of its central square. The production of anthracite coal in Luzerne County, of which it is the court-house town, is worth more than the gold production of the United States, Alaska included. In the beauty of its buildings, the character of its citizenry, the extent of its civic development, the strength of its financial resources, and the progressiveness of its policies, the city can stand comparison with any urban community of like size anywhere.

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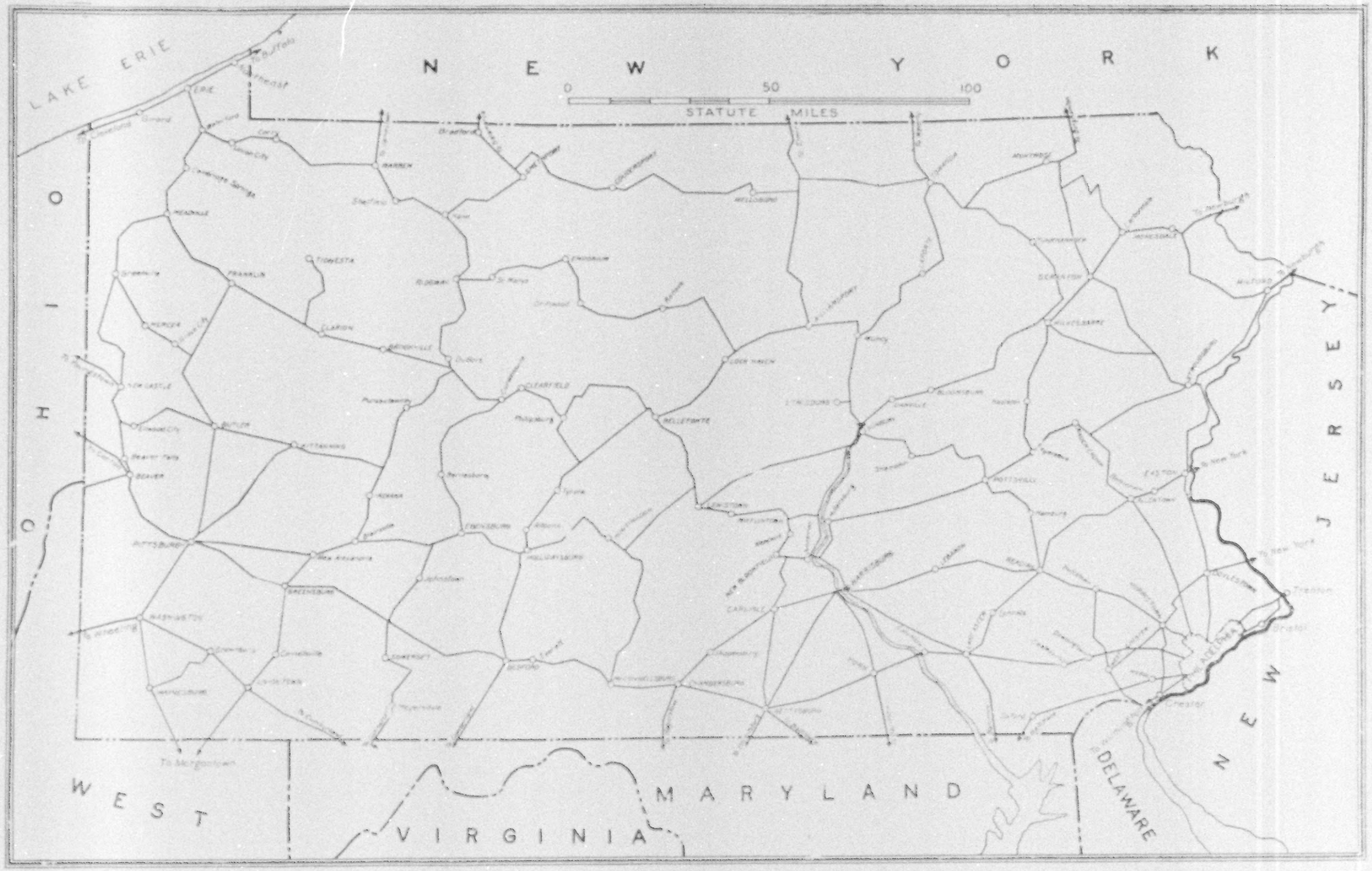

A CONCRETE EXAMPLE OF PENNSYLVANIA'S FORESIGHT IN PROVIDING FOR HER ECONOMIC DEVELOPMENT: THE COMPREHENSIVE PLAN UNDER WHICH THE STATE HIGHWAYS ARE BEING CONSTRUCTED

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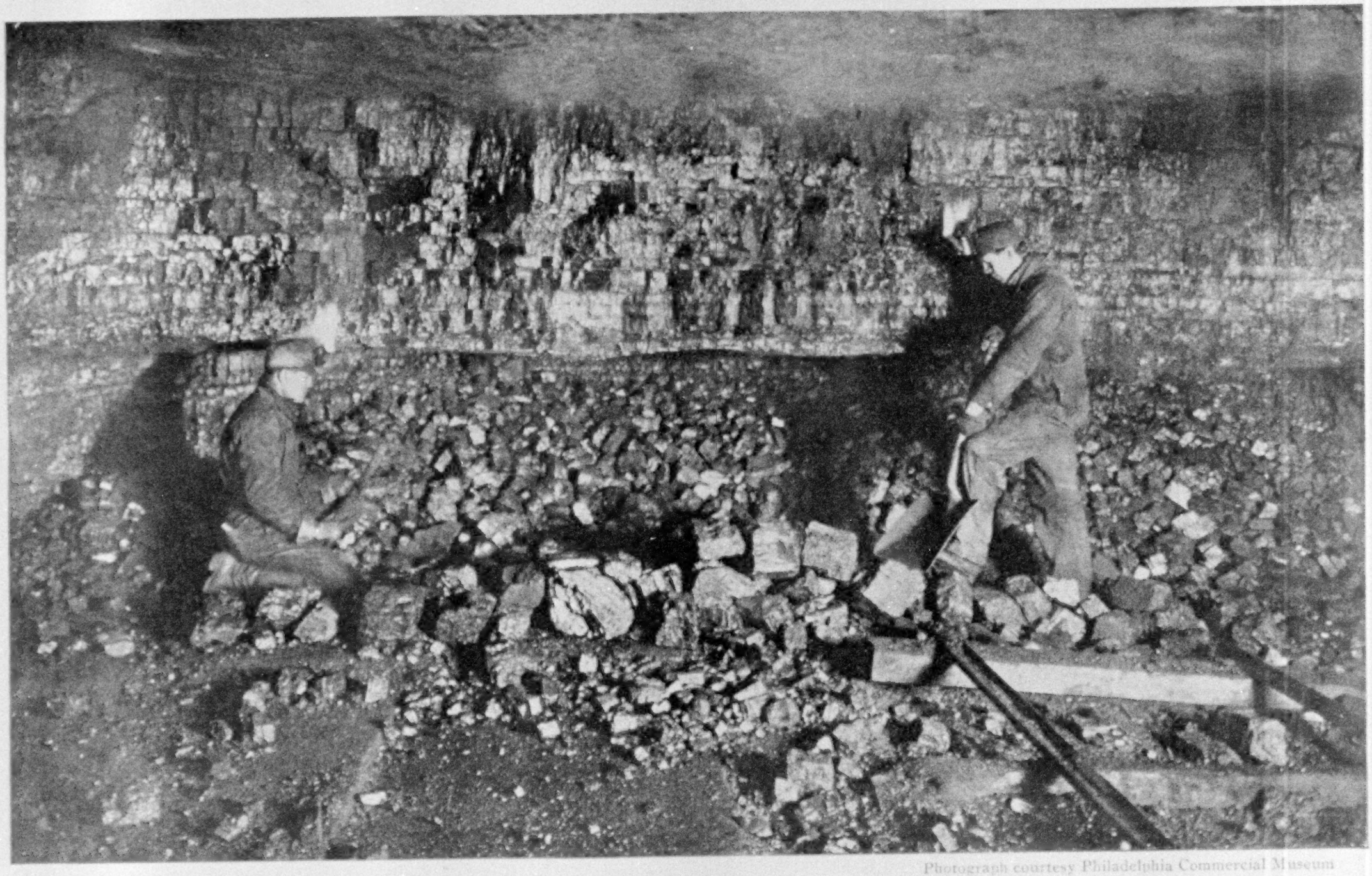
STARTING ON THE ROAD TO GOOD CITIZENSHIP

Pennsylvania's staunchest admirers confess that the State's elementary educational system is far from ideal, with eleven thousand of its teachers receiving salaries of less than $500 a year. The best interests of the future citizens of the Commonwealth are served only when their educators are thoroughly trained and adequately paid.



Photograph courtesy Philadelphia Commercial Museum

STALKING STEAM TO ITS SOURCE

Burrowing away in the world of eternal night beneath the surface, the miners are the men behind the wheels of almost every Pennsylvanian industry. No other similar area in the world gives employment to as many miners as the coal lands of Pennsylvania.

Nowhere else in the world can fuel for power purposes be bought more cheaply than at Wilkes-Barre. Black diamonds in unbelievable quantities lie, ready to be mined, directly beneath the city's factories; and hundreds of millions of dollars are invested in the long list of industries that seek cheap power and make good profits here.

Who that has traveled from Mauch Chunk to Wilkes-Barre on the Black Diamond or the Scranton Flyer has not admired the day scenery on the one or the night scenery on the other? Two railroads hug the Lehigh River from Mauch Chunk to White Haven, through as wild a mountain region as can be found east of the Rockies. From there they reach the top of Nescopeck Mountain above Penobscot by diverse routes. Behind the traveler lies a branch of the Lehigh Valley, with its rugged scenery, and in front of him is the wonderful Wyoming Valley, with collieries as thick as hops, and Wilkes-Barre a quarter of a mile beneath him.

And at night, as the summit of the mountain is passed and myriads of lights, bright and dim, yellow and white and blue, flash up from Wilkes-Barre and its dozens of adjacent towns in the valley far below, the traveler passing that way for the first time well may wonder whether the heavens have of a sudden been inverted, or whether a great silver lake beneath him is reflecting thousands of stars.

HOW ERIE BECAME A PART OF PENNSYLVANIA

The story of how Erie became a part of Pennsylvania might have served as a tip to the Peace Conference on corridors to the sea. New York's charter defined its western boundary as the meridian line extending southward to the forty-second parallel of latitude from the western extremity of Lake Ontario. It was always assumed that the Pennsylvania-New York line would extend directly into Lake Erie, and that therefore the Erie site and Presque Isle belonged to New York. But the actual survey revealed the fact that there was a small triangle that did not belong to either State.

Thereupon Massachusetts and Connecticut both claimed it, on the ground that the charter of the Plymouth Company gave them all the land lying in their latitude as far west as the Pacific Ocean, not previously settled by other Christian powers. After protracted negotiations, New York, Massachusetts, and Connecticut released their claims in favor of the Federal Government, which, in turn, sold the land to the State of Pennsylvania, giving her a harbor on the Great Lakes. However, Connecticut, in consideration of her release, reserved a tract in northeastern Ohio. Hence, the Western Reserve of the Buckeye State.

Situated between the coal of Pennsylvania and the ore of Minnesota, possessed of one of the finest harbors on the Great Lakes, Erie is host to some five hundred manufacturing establishments. It has the largest horseshoe factory and the largest pipe-organ plant in the world, and makes more baby carriages, gas mantles, and clothes-wringers than any other city.

It is one of the few industrial cities of America that is resolved not to neglect the esthetic side of its development. In pursuance of that purpose, it borrowed a chapter from the history of Chicago and created a city planning commission which has laid out a goal for Erie to grow up to.

CITIES WHICH BOAST SUPERLATIVE INDUSTRIES

Each of the State's lesser centers of population possesses some industry in which its citizens experience justifiable pride. Harrisburg, in addition to enjoying the distinction of being the Commonwealth capital, is one of the principal railroad centers of the East, while one of its suburbs indicates in its name, Steelton, the nature of its industrial interests. Johnstown, likewise, is an iron and steel center.

If quantity and quality of the manufactured product signify, Allentown is the world's cement capital, for two-fifths of America's output is produced within a radius of 20 miles of this beautiful city of homes, which is also noted for its silks.

Walk from one end of its main street to the other in the summer-time and every lamp-post you see supports a basket of flowers. Think of a bouquet-studded

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street several miles long. In the winter evergreens take the place of the blossoms in the baskets. The effect is charming. But it is characteristic of Allentown and the spirit of Pennsylvania.

The importance of Altoona's railroad shops is indicated in the fact that nearly half as many people found employment in them before the war as were required to man the Federal Government machine in Washington.

Lancaster's claim to fame is expressed in three superlatives: the largest linoleum factory, the largest umbrella factory, and the largest silk mill in the world. In addition, its output of books and magazines devoted to science is extraordinary, and its stockyards are the most extensive east of Chicago. One of the finest watch factories in the world is located here, and, although its industries give employment to 23,000 operatives, the city has never had a strike.

York prides itself on the diversity of its industries rather than upon the magnitude of any one, and in this particular it takes rank after Philadelphia and Pittsburgh. McKeesport's pride in the largest tin-plate plant in the world is justified, while Newcastle produces more tin in sheets and blocks than any other city; Chester is a veritable Vulcan-shop, with ships sliding from the ways, locomotives rumbling from its shops, and shells coming by the carload, in war time, from its munitions plants.

And so the story goes, from Pennsylvania city to Pennsylvania city. Where the ambition of one turns in the direction of silk, or tin, or heavy forgings, another is the center of a rich agricultural district, or finds gratification in the fact that it is distinguished for safeguarding and improving its people's health. Take a map of the State, and every dot representing a community of 10,000 or more inhabitants would furnish a text for an article on civic progress or industrial enterprise.

Outside of Philadelphia, Pennsylvania is much more populous than is New York outside of New York City. Indeed, Pennsylvania goes down to Philadelphia with 6,325,000 population, while New York goes down to the Bronx with 4,723,000.

It is the large number of cities of less than thirty thousand population that makes Pennsylvania, outside its chief city, such a populous State.

A MONUMENT TO RELIGIOUS FREEDOM

No bit of literature compiled regarding Pennsylvania could fairly represent that State without at least a passing reference to the religious sects which were transplanted there in colonial times and which flourish to this day in nearly their primitive simplicity.

When William Penn founded his colony, the central purpose of his life was to establish an asylum where the persecuted of all lands could come and worship God according to their own consciences and live according to their own religious convictions.

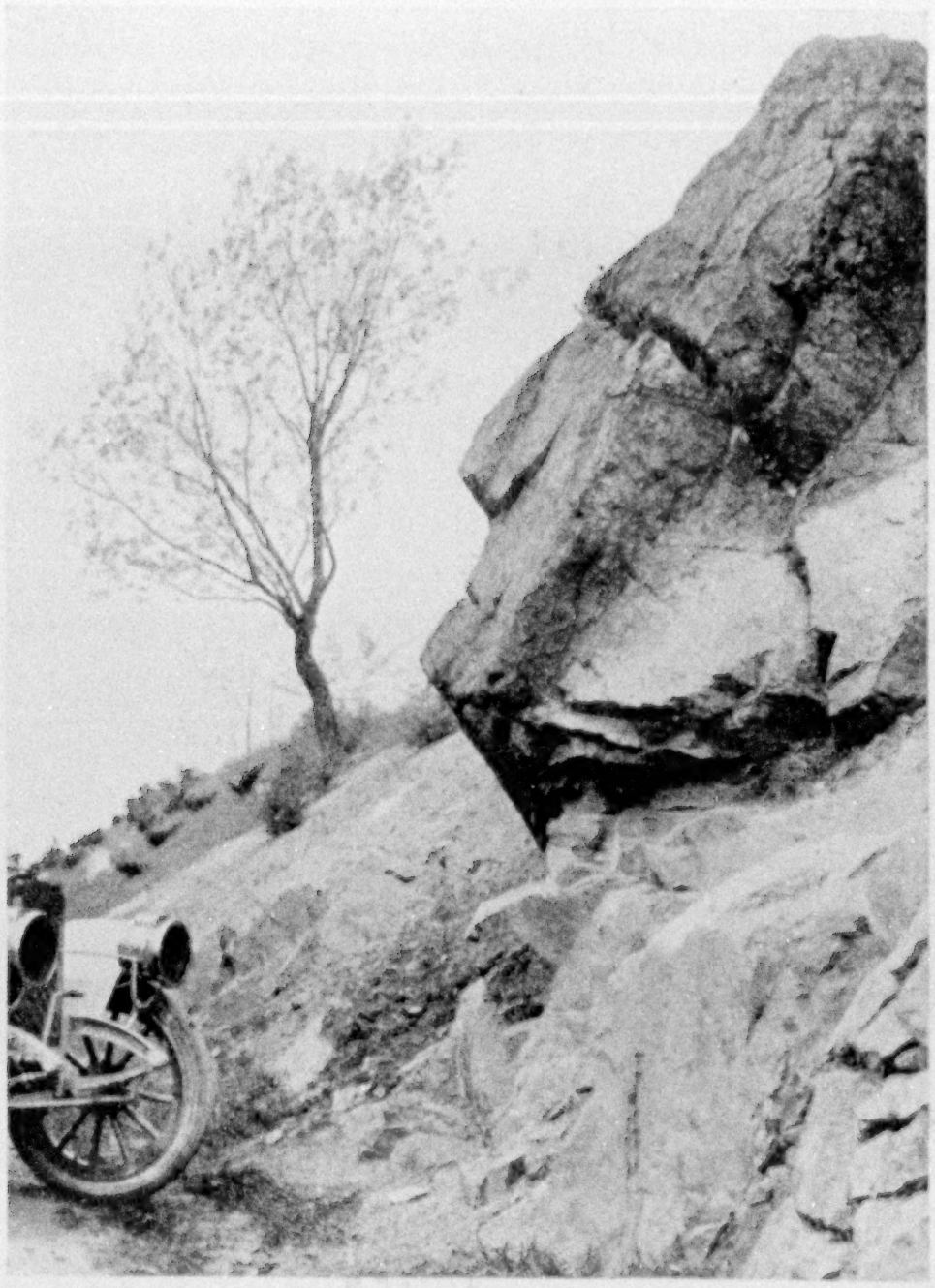
The Quakers came by the thousands. Their meeting-houses sprang up everywhere. Not content to express their religion in their walk and conduct, they gave it expression in their dress and in their very words. The broad-brimmed hat and the Quaker bonnet were seen and the "thee" and "thou" were heard everywhere. The lives the Quakers lived won the admiration of all who came into contact with them, and much of the solid development of the State is due to the high standard of integrity and fairness established and maintained by these people of Quaker faith.

Mennonites from Holland and Switzerland and the Rhine Country, persecuted by nearly all creeds alike, came in large numbers and developed into the successful agriculturists of the three original counties. The Dunkers of Switzerland came as a body, root and branch. The Schwenkfelders of Silesia, distressed by persecutions that were without pity, braved the perils of raging seas and untamed forests in order to find a haven where they could live in their faith. The Moravians followed later, to share with the other sects the blessings of tolerance in the land of Penn.

Humble, unsung, content to play their quiet rôles without the applause of men, like the bee that renders an unconscious service to the flower, these sects have wrought richly in the making of the nation.

It seems like going back into an earlier century to visit the cloisters of Ephrata and Nazareth; it appears passing strange to see the Amish Mennonite, with his tailless coat and broad-brimmed hat, on the streets of progressive Lancaster; it surprises the visitor to Allentown to hear well-dressed, up-to-date people, from court officer to manufacturer, talking Pennsylvania Dutch!

Yet millions of America's best farmers inherited their command of the soil from such ancestry; from such simple folk have sprung scores of governors of States, many jurists, a galaxy of educators, etc. The Pennsylvania pietist, in his ascetic way, has done his bit in making his State what it is—and his part in shaping the bone and sinew of the nation.



Photograph by G. A. Conradi

WASHINGTON PROFILE ROCK, SAYRE PARK, LEHIGH UNIVERSITY; SOUTH BETHLEHEM

Her magnificent highways and the eye-filling scenery of such regions as the Delaware Water Gap have an irresistible lure for the pleasure-seeking autoist.

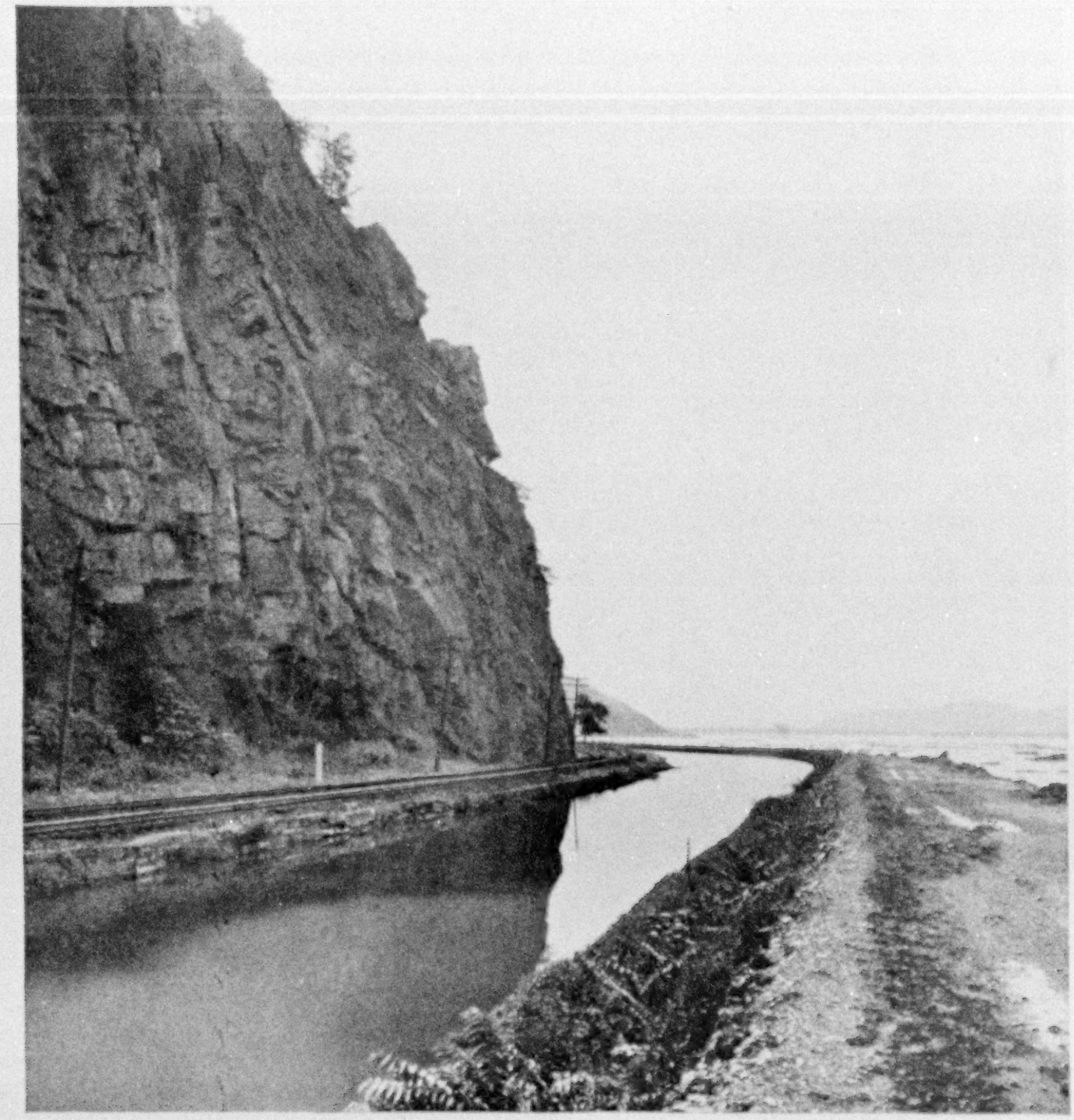
THE STATE'S SHARE IN MAKING AND PRESERVING THE UNION

As for its history, whether in the remoter period of colonial times or in the just-passing era of America's activities in the world war; whether in the battle for the establishment of the Union or the struggle for its maintenance, the Keystone State has always played a rôle second to no other Commonwealth. It was on Pennsylvania soil that the Declaration of Independence was written; that the disheartened colonists were reorganized for victory at Valley Forge, and upon which the Constitution of the United States was proclaimed.

It was from Pennsylvania that the men came who shed the first blood in the Civil War, and at Gettysburg the tide against disunion was turned, under the leadership of a Pennsylvania soldier.

When America threw the weight of its power into the balance in the Armageddon of liberty in Europe, Pennsylvania was in the van of those ready for action.

No other division in France, outside of the Regular Army forces, was earlier in the fray than the Twenty-eighth, made up largely of Keystone troops. With



Photograph by William H. Rau

ALONG THE SUSQUEHANNA RIVER NEAR COLUMBIA, PENNSYLVANIA

Railroad, canal, and river here sweep in splendid curves around the lofty rocks that make the valley little more than a gorge.

casualties of 14,417 in the 177 days between arrival at A. E. F. headquarters and the armistice, the division made a record not surpassed in the war. For 49 days it was in the very thick of the hardest fighting of the conflict.

The State gave 298,000 men for the Army, 29,000 for the Navy, and 3,000 for the Marine Corps—a grand total of 330,000 men, to say nothing of the hundreds of thousands of workers in shipyards, munition plants, etc., who answered their country's call.

Of course, Pennsylvanians are proud of their State's rôle in the nation's activities. And the coming of peace will find them at the forefront of those who shall provide the world with the munitions of peace—engines and cars, coal and steel, a thousand commodities, in the making of which Pennsylvania serves doubly—herself and the whole world.

HUNTING BIG GAME OF OTHER DAYS

A Boating Expedition in Search of Fossils in Alberta, Canada

By Barnum Brown

Associate Curator of Vertebrate Paleontology in the American Museum of Natural History

With Photographs from the American Museum of Natural History

SINCE the days of our jungle forebears the quest of big game has appealed to man, his appreciation of the sport being measured chiefly by the size of the game and the difficulty of securing it.

Today we must go to Africa for the biggest game; but there was a time in the dim distant past when America produced animals larger than any now living. That was so long ago that nothing remains of these creatures except their bones, and they are turned to stone. Hidden away under strata of earth, their spoor has long since grown cold, and the hunt I shall describe is in consequence difficult.

The animals are dinosaurs; for the moment we will call them lizards—not the creeping, crawling kind, but huge reptiles that stalked upright through the jungles, rivaling in size the elephant, the hippopotamus, and the rhinoceros.

The place is Alberta, Canada, and the time of their existence 3,000,000 years ago.

Between the Great Lakes and the Rocky Mountains, just north of the Canadian boundary, lies a vast area of level land, prairie in the east and forested near the mountains, with a narrow intervening section that is brush-covered. East of the timbered belt the central part of Alberta is level as far as the eye can see and dotted here and there by small glacial lakes, where nest countless numbers of ducks and geese (see map, page 425).

THE CANADIAN FARMER'S ELDORADO

Fifteen years ago this level section was prairie land covered with a luxuriant growth of grass, on which grazed comparatively few cattle, with a ranch building here and there, but sparsely settled withal. Today the country is covered by a network of railroads, and near the railroads most of the available land is homesteaded.

The soil is very rich and of considerable depth, producing under favorable conditions enormous yields of small grain, yet only a fraction of the country is under cultivation. When fully producing, the future wealth of this great territory cannot even be estimated; it is the Canadian farmer's Eldorado.

A number of small rivers drain this area, uniting in the province of Alberta to form the Saskatchewan, which flows into Lake Winnipeg. The Red Deer River is one of these tributaries that rises in the mountains north of Banff. Numbers of lesser streams fed by mountain snows and prairie lakes join it, making an irresistible stream that has cut through the prairie land, forming a miniature grand canyon, a mile wide at the top and from two to five hundred feet deep.

ONCE THE BED OF A GREAT INLAND SEA

Although black, fertile soil forms the surface of the country, the earth below is composed of horizontal layers of clay and sandstone, and a journey of 250 miles down the river reveals four distinct geologic periods in the canyon walls. The strata representing these periods overlap like shingles on a roof, and in each are preserved the fossil remains of animals and plants which enable us to picture former conditions and life during past ages (see picture, page 413).

In the lower reaches of the river, 200 miles from the mountains, only sea-shells are found in the rocks, indicating that the

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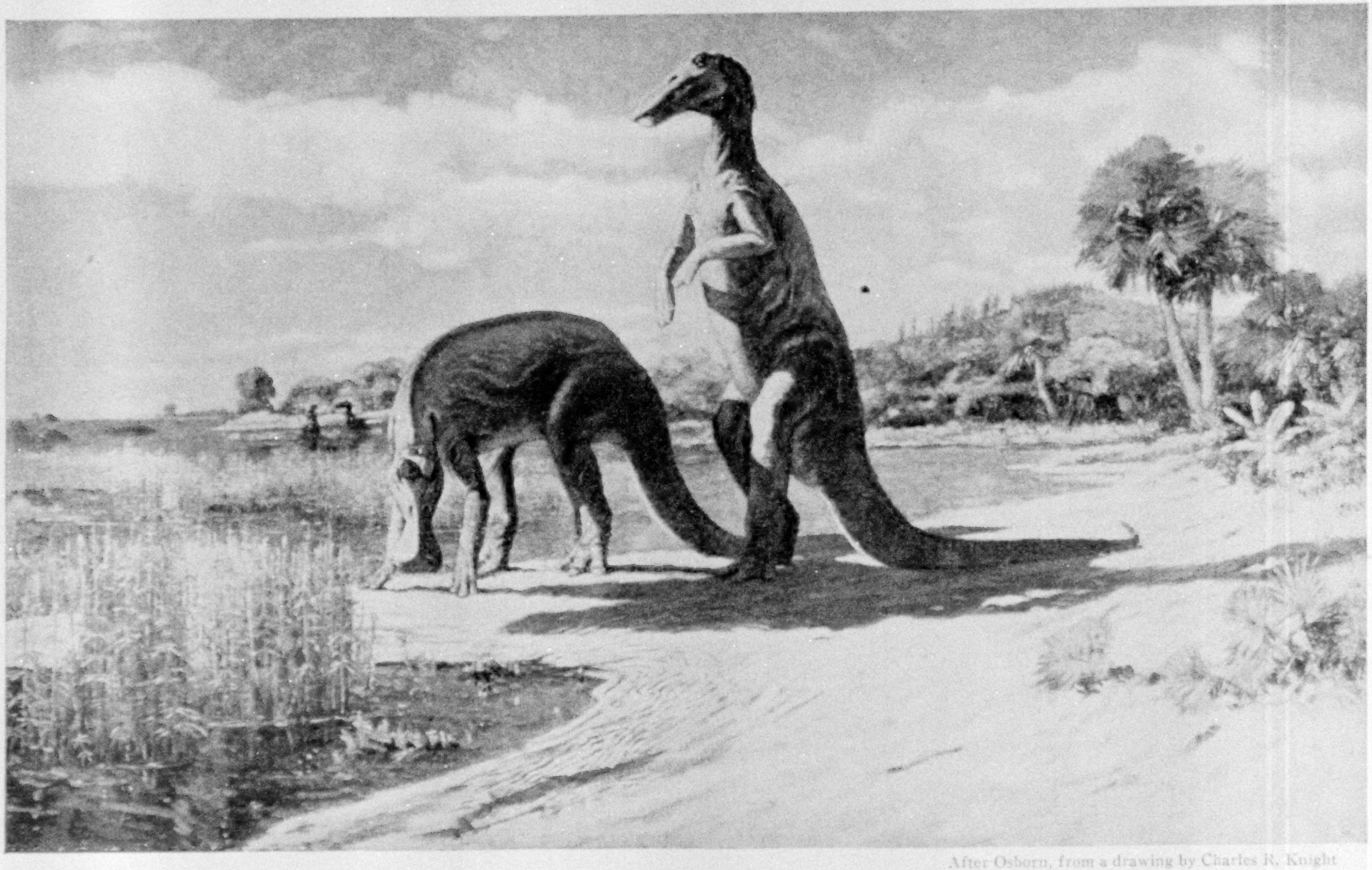
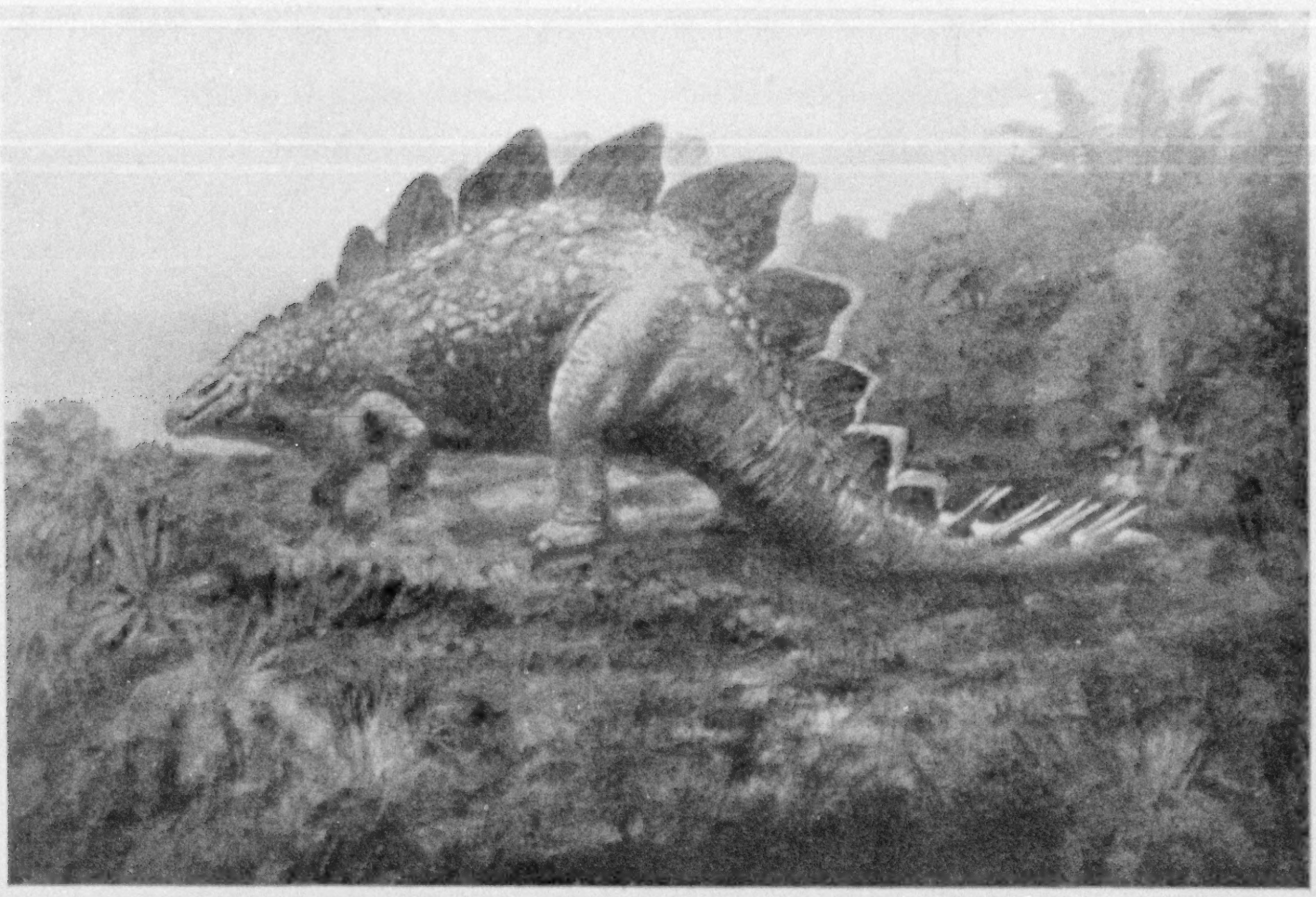


After Osborn, from a drawing by Charles R. Knight

BIG GAME OF OTHER DAYS (SEE PAGE 411)

These singular dinosaurs were semi-aquatic in their habits and had large, duck-like heads. They were rather delicately made, in spite of their great size, and were quite inoffensive. Several specimens have been found showing the impression of the skin in a perfect state.



From a drawing by Charles R. Knight

A COMMON SIGHT IN NORTH AMERICA MILLIONS OF YEARS AGO

The most extraordinary feature of this animal was the row of thin plates on either side of the median line, and also the long and heavily armed tail.

ocean—an inland sea extending from the Gulf of Mexico northward to the Arctic Ocean—covered this area during a long time, in which several hundred feet of strata accumulated.

Where these rocks flank the mountains they are tilted at an angle of several degrees, which shows that they were laid down before the complete elevation of the Rocky Mountains. This formation is called the *Pierre*. (Geologic formations are usually named from the "type" locality in which first recognized, and wherever rocks of the same age appear they are designated by that name.)

Near the close of the *Pierre* a part of the inland sea-floor was elevated above the ocean and became a land-mass of low altitude—a vast stretch of jungle-covered delta and coastal swamp, interspersed with bayous and lagoons.

In the fresh and partly salt or brackish water lake and river beds of this period are preserved leaf impressions of a variety of trees, rarely teeth and fragmentary bones of mammals, and numerous remains of a great variety of reptiles (see page 416). This is known as the *Judith (Belly) River* formation.

Subsequently this area again sank below the sea for a long time and 400 feet of deposits accumulated, in which only sea-shells and marine reptiles are to be found. This ocean deposit, also a part of the *Pierre*, is designated *Bearpaw*.

Then a long period of elevation began, the rocks and fossils showing a gradual change from salt to brackish water conditions, which near the top became quite fresh. These beds, over 700 feet thick, are known as the *Edmonton* formation. Presumably the area was near sea-level and subject to frequent invasions of the sea—a condition that may be better understood by comparison with the present everglades of Florida (see page 412).

THE HOME OF A HOST OF REPTILES

In these marshes of prehistoric times dwelt a host of reptiles, some large, some small, and of various forms, flesh-eaters and herb-eaters, but all sharing certain characters in common and known as dinosaurs. Not any were closely re-

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A SPORTSMAN'S PARADISE WHEN THE QUARRY IS BIG GAME OF OTHER DAYS

For miles along the Red Deer River there is no sign of human habitation, but above on the prairie every quarter section of land forms a homestead. The dark objects on the horizon are haystacks. The cliffs of the river are filled with remains of primitive dinosaurs, turtles, and crocodiles.

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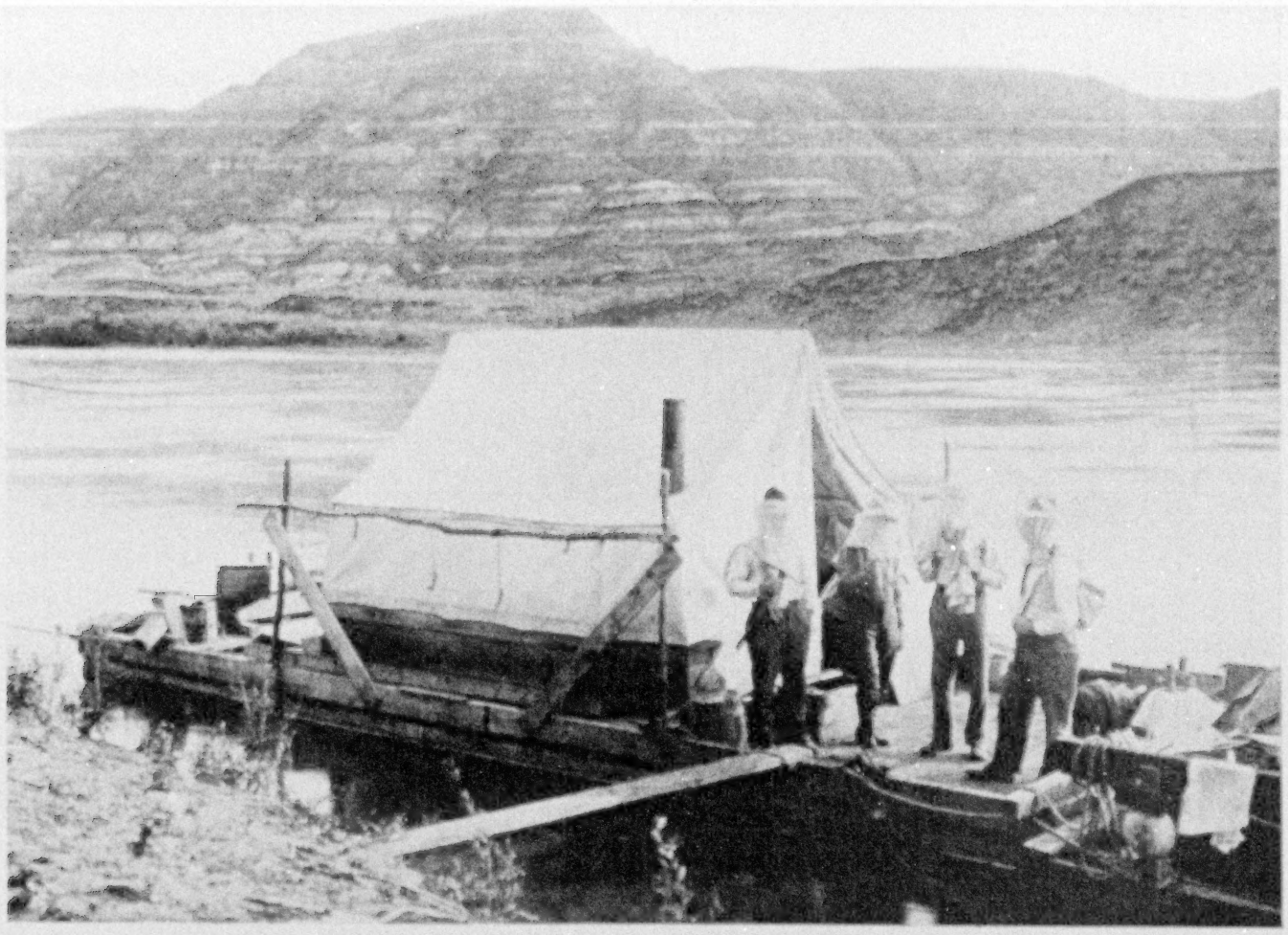

THE BIG GAME HUNTERS' MOVING CAMP

The big flat-boat drifts downstream with the current. It is steered from the stern, and by concerted action of both oars can be pushed broadside to avoid rocks. The mosquitoes are often so thick that no one can work without a net over the face and gloves on the hands.

lated to any living reptile, yet they had some characters common to the lizards, crocodiles, and birds.

Of the kinds characteristic of the period one species, an herb-eater named *Trachodon*, was more than 30 feet long and about 15 feet high when standing erect (see page 408). Its head, with broadly expanded mouth, resembles that of a duck, but back of the beak there are more than two thousand small teeth, disposed in many vertical rows, each containing several individual teeth, the new ones coming up from below as the old ones wore out.

The long hind legs terminated in three large hoofed toes, and the shorter, slender front feet were partly webbed. A long, thin, slender tail acted as a powerful swimming organ, and the body was covered with rough tuberculate skin. Having no means of defense, it lived chiefly in the water, where it was free from attacks of the flesh-eaters.

With the "duck-billed" *Trachodon* there were other large closely related forms inhabiting the water. *Saurolophus* was similar in build, but characterized by a large crest extending above the skull, and pelvic bones that were developed for attachment of powerful tail muscles. It was probably a distinctly aquatic type (see page 418).

A DINOSAUR WITH PNEUMATIC BONES

Along the shores lived *Ornithomimus*, bird mimic, as the name implies, one of the most remarkable of the dinosaurs. A skeleton found last year shows it to have been a toothless creature, the jaws sheathed like the beak of a bird.

The bones were light and pneumatic, like those of birds, but the skeleton closely resembles that of the flesh-eating dinosaurs. It was about 12 feet in length, with long, slender hind legs and shorter front legs. This was an agile creature, different from the typical flesh-eaters in feeding habits and doubtless a shore-living type that may have fed on crustaceans.

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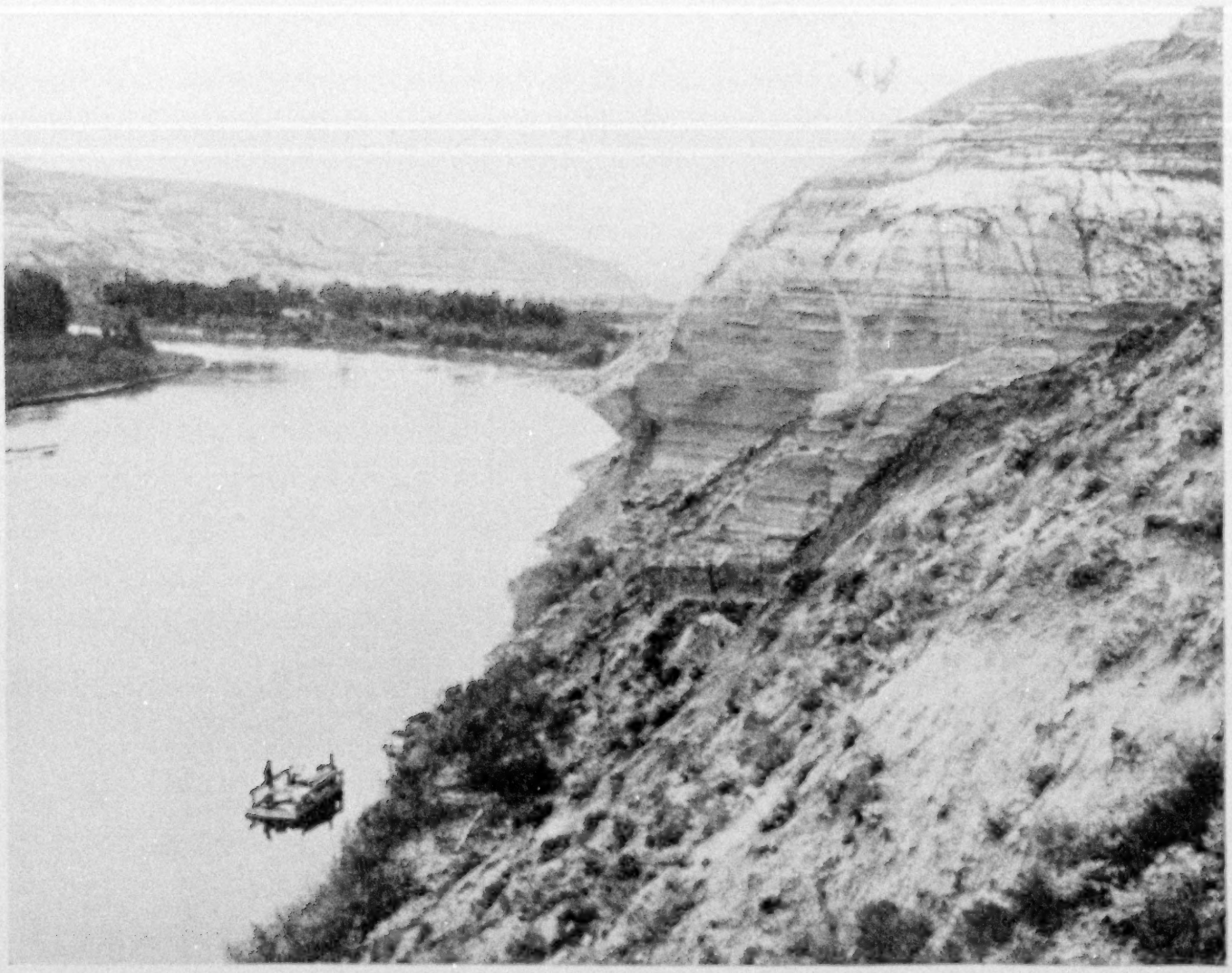
AN IMPORTANT PAGE OF GEOLOGIC HISTORY: MARKING THE CHANGE FROM PURELY MARINE TO CONTINENTAL CONDITIONS, NEAR THE MOUTH OF WILLOW CREEK

The man stands on ocean sediments of Pierre Age (see page 409), above which are the conformable brackish-water Edmonton beds that contain dinosaurs.



SCANNING THE CLIFFS FOR SLEEPING MONSTERS

In a single quarry along these cliffs bones representing several hundred individuals have been washed out of the bank.

On land there were hoofed quadrupedal herbivorous kinds, some, like *Monoclonius* (see page 426), having an immense skull, six feet in length, with three horns, a short one over each eye and a longer one above the nose. The jaws terminated in a sharp clipping beak, like that of a turtle, and further back in the mouth there were rows of double-rooted teeth. The back of the skull was developed into a broad shield, with scalloped border, extending over the neck. It was ancestral to the later *Triceratops*.

A CREATURE FULLY ENCASED IN ARMOR, INCLUDING VISORS TO SAFEGUARD HIS EYES

Strangest of all was the herbivorous *Ankylosaurus*, a stocky, short-legged, big-bodied creature, completely encased in armor. Dermal plates covered the skull, followed by rings of plates over the neck and rows of flat plates over the back and hips. Its tail terminated in a huge club, and the belly was covered by a pliable mosaic of small, close-set plates. It was further protected by a movable plate that could be dropped down like a shutter over each eye, thus completing its protection from insects and formidable foes.

Preying on the various herbivorous kinds were powerful flesh-eaters, *Albertosaurus*, resembling those shown on page 429—an active animal 30 feet long and about 15 feet high. Armed with large, serrate dagger teeth and sharp, bird-like claws, it was capable of destroying any of its herb-eating relatives. It walked habitually on its hind legs, balanced by a long tail, while the short, reduced front legs could have been used only in grasping its prey.

That great numbers of these creatures lived in the ancient marshes is evident from the numerous remains found in the rocks. In a single quarry, of which there are many on the Red Deer River, bones representing several hundred individuals have been washed out of the bank, and more or less complete skeletons and in-

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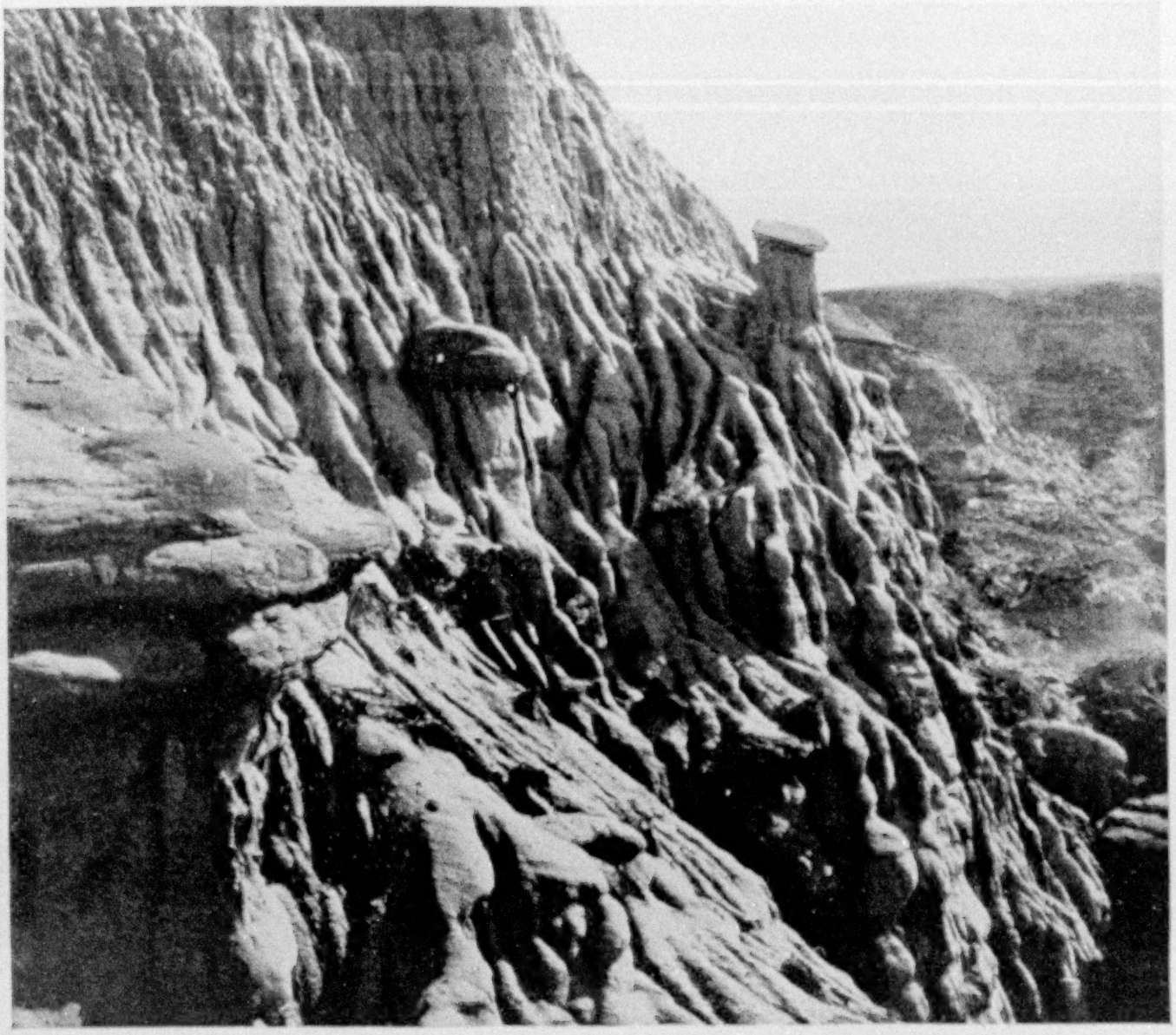

HIGH UP ON THE FACE OF A STEEP CLIFF WE FOUND A PARTIAL SKELETON OF THE WONDERFUL ARMORED DINOSAUR ANKYLOSAURUS (SEE PAGE 413)

The skull lies just above the pick. The skeleton was disarticulated, but all bones were found on the same level as deposited millions of years ago. To secure the specimen, the whole face of the hillside was blasted off, making a cut 30 feet long, 40 feet high, and 20 feet back into the hill, before all of the bones of this specimen were secured.

dividual bones are scattered all through the strata.

WHEN SOUTHERN CANADA HAD A FLORIDA CLIMATE

At that time southern Canada and the northern part of the United States enjoyed a climate similar to that of Florida, for fig fruits and palm leaves are often found in these same rocks. Numerous coal veins and petrified wood bespeak the tropical abundance of the vegetation.

Above the *Edmonton* beds, flanking the mountains, there are several hundred feet of sandstones and clays called the *Paskapoo* beds, which were deposited after the dinosaurs became extinct (see page 412).

These strata mark the beginning of the Age of Mammals. The giant reptiles had disappeared; their remains are never found in this formation; but in places the beds contain mammal teeth, small bones, leaves, and fresh-water shells.

It is probable that when this formation was deposited the country had been sufficiently elevated to drain off the marshes, and that the drainage of the waters was the chief cause of extinction of the dinosaurs. They were creatures that did not migrate any great distance to more favorable conditions, as do mammals, and it is quite possible that the particular food of the herbivorous forms became scarce. The known plant remains are

"BAD LANDS" OF THE EDMONTON FORMATION OPPOSITE THE MOUTH OF BIG VALLEY

This is the most picturesque section along the Red Deer River. Rains rapidly wash away the soft, friable clays, eroding the hillsides like organ pipes and exposing the fossil bones. The hard sandstone layers resist erosion and form terraces. Here we found dinosaur bones in abundance.

quite similar to those in the rocks immediately below, and inferentially the temperature had not changed.

The geologic formations along the Red Deer were first determined by the Canadian Geological Survey, members of which secured a variety of fossils, chiefly from the *Judith (Belly) River* formation, where the fossils are better preserved and more abundant than those in similar rocks in the United States.

HOW AND WHERE COLLECTORS HUNT BIG GAME OF THE PAST

Usually fossils are found in "Bad Lands," a name applied by the Jesuit missionaries to desolate regions denuded of grass and eroded into picturesque hills and ravines. In such places camp is located near some spring or stream, and the collectors ride or walk over the exposures till the region is thoroughly explored.

Quite different are the conditions on the Red Deer River. In places the canyon walls are nearly perpendicular, and the river winds in its narrow valley two to five hundred feet below the prairie, touching one side, then crossing to the other, so that it is impossible to follow up or down its course any great distance, even on horseback.

For many years the American Museum of Natural History of New York City has been making a systematic collection of fossils along this river, sending an expedition there every summer, and each succeeding expedition has returned with notable results. As the only feasible way to work these banks is from a boat, the parties proceed to the town of Red Deer, where the Calgary-Edmonton Railroad crosses the river.

There, with the aid of several carpenters, we constructed a flat-boat, 12 by 30 feet in dimension, similar to a Western

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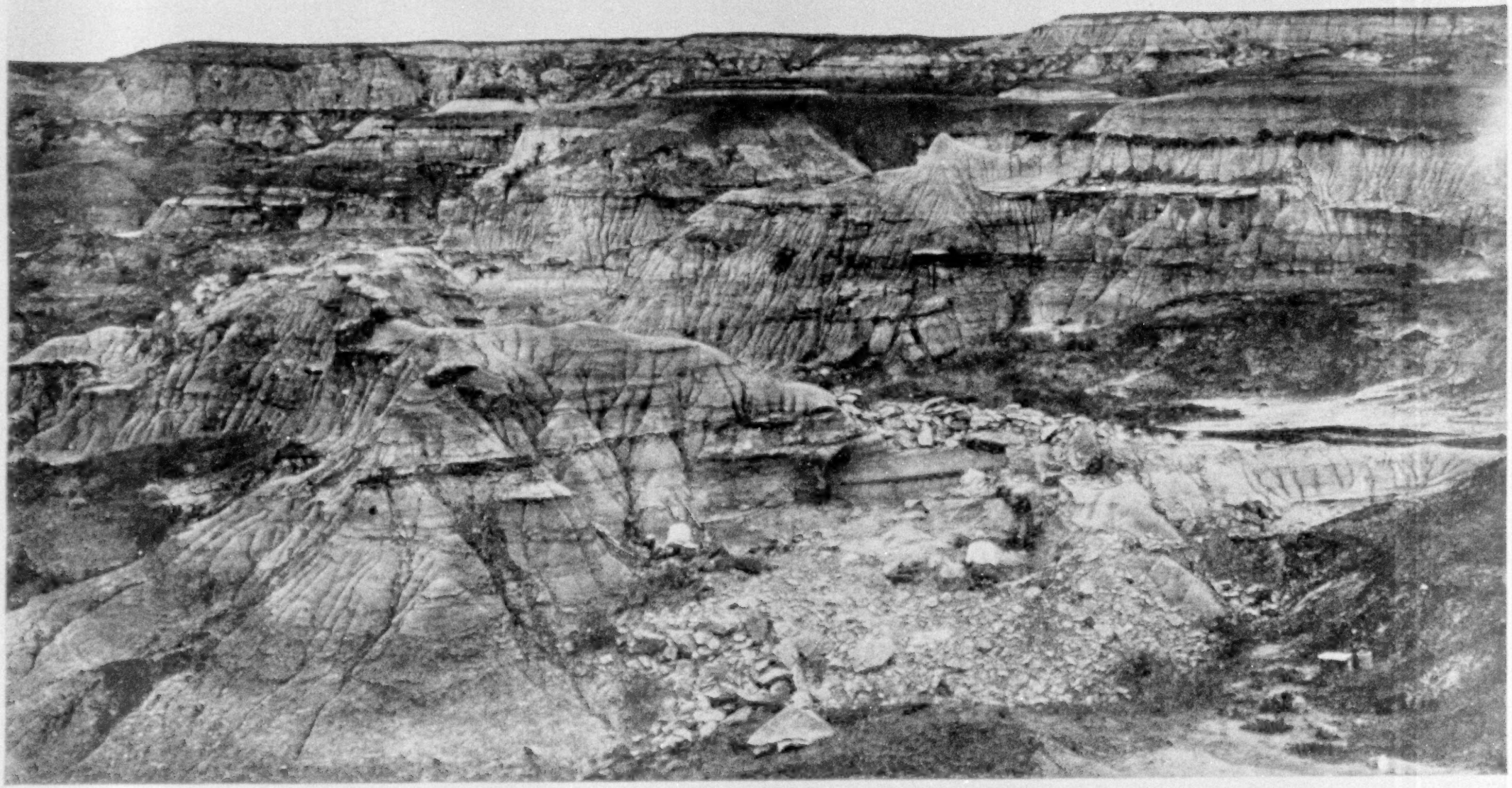
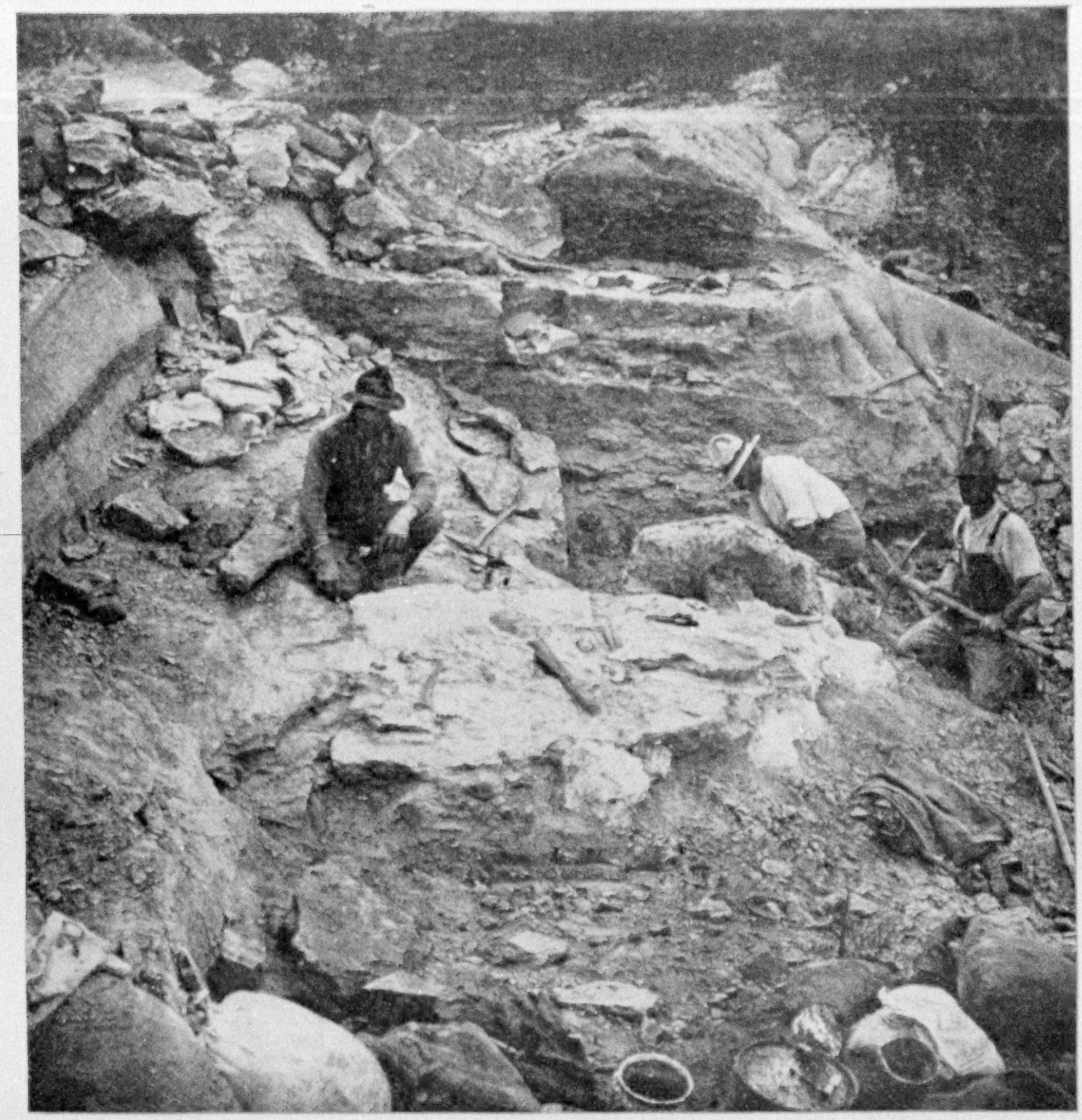


THE PICTURESQUE "BAD LANDS" OF THE BELLY RIVER FORMATION AT THE HEAD OF SAND CREEK, UNUSUALLY RICH IN MORE OR LESS COMPLETE SKELETONS (SEE ALSO PAGE 422)



ONE OF THE HORNED DINOSAURS, MONOCLONIUS (SEE PAGE 426)

This skeleton was complete from the tip of the tail to the end of the beak. Even the tongue bones were preserved in position.

ferry-boat. It was built upside down, and when calked water-tight was turned over and launched in the river near by. This boat was capable of carrying ten tons with safety (see page 411).

As the river has a speed of four miles per hour, we never intended to go upstream; so the boat was made on broad lines to be carried down by the current, its course directed by two great sweeps, or oars 22 feet long, one at each end of the boat, and nicely balanced on the gunwale, so that a man could push against it with his entire strength.

Supplied with a season's provisions, lumber for boxes, and plaster for encasing bones, we began our fossil cruise down a canyon that once echoed songs of the "Bois Brûlé," for this river was at one time the home of many fur-bearing animals and within the Hudson Bay Company territory.

The first sixty miles of the river below the town of Red Deer is locally known as "the Canyon," where the speed of the current is considerably more than four miles per hour, but there are alternating stretches of slow-moving water and rapids at low water dangerous to rafts and large boats.

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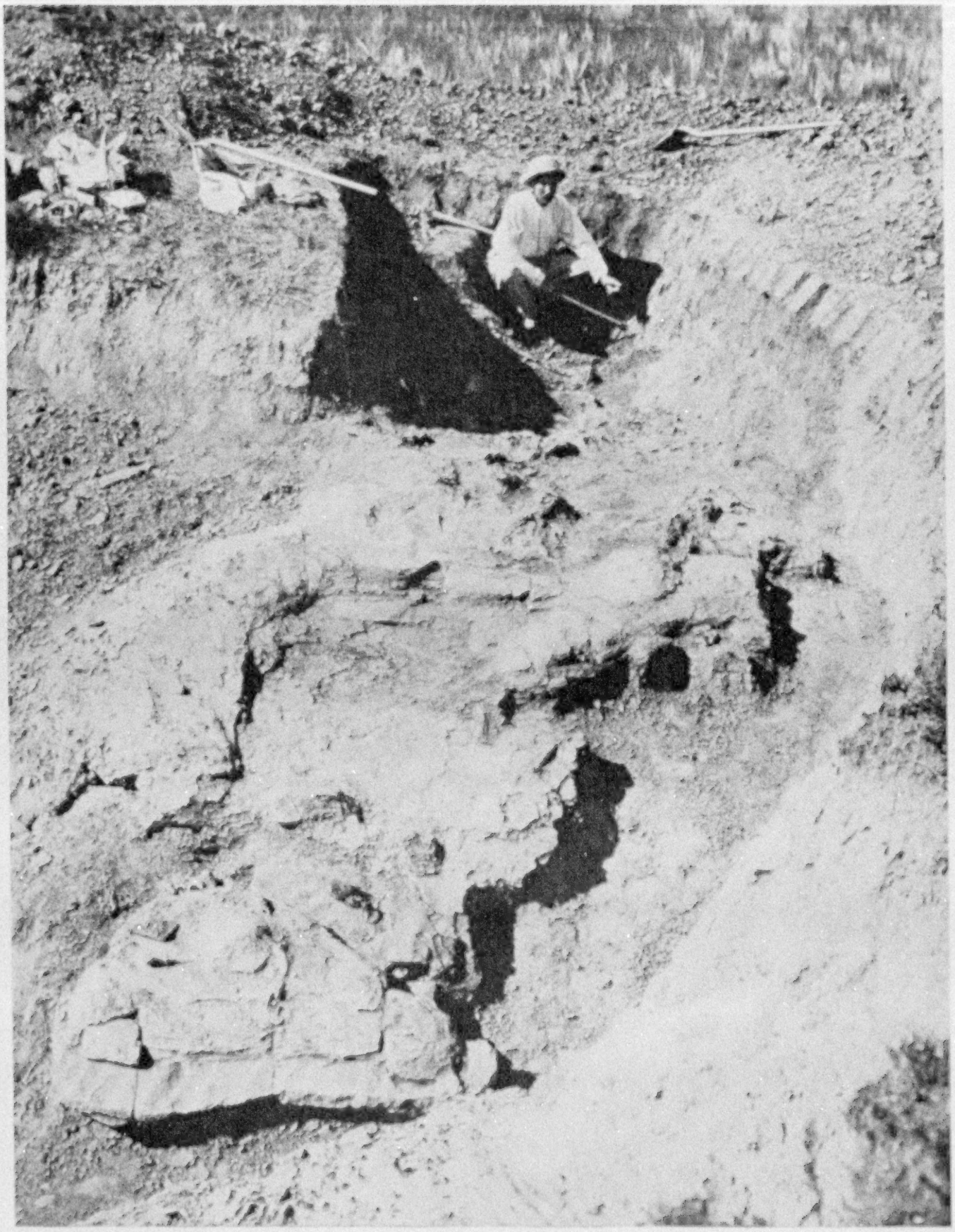
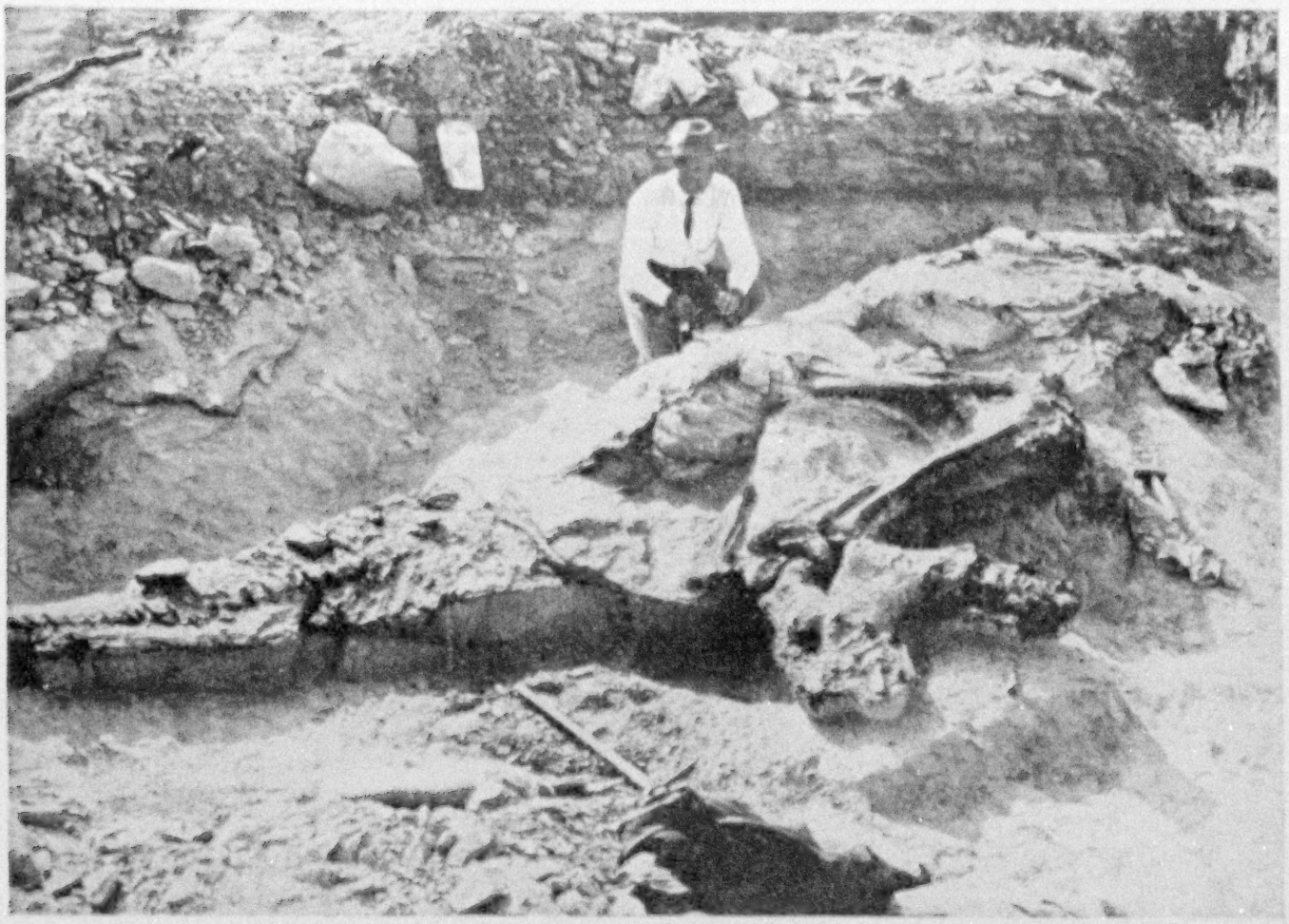


THE SAUROLOPHUS SKELETON UNCOVERED AND READY TO BE ENCASED IN PLASTER AND BOXED, PREPARATORY TO ITS LONG JOURNEY TO THE MUSEUM

The skull at the lower end of the picture is still surrounded by ripple-marked sandstone; the tail extends under the man. It was covered over by four feet of clay and a few spines of the vertebræ were sticking out of the bank, giving us a clue to its location.



THE SKELETON OF THE NEW CRESTED DINOSAUR, CORYTHOSAURUS, FOUND NEAR STEVEVILLE

This is an unusually complete skeleton more than thirty feet long, with the impression of the skin still preserved on the under side. In this type of "duck bill" the skull was surmounted by a high, curved crest, like that of a cassowary. The end of the tail was exposed, giving a clue to the skeleton.

Spruce and poplar trees cover this section of the country, and each bend of the river presents some picturesque vista of especial interest, the stately spruce trees, silhouetted against the sky, adding a charm to the ever-changing scene. Forest fires and lumbermen have thinned out most of the larger trees, and for miles along the river the underbrush was colored pink by the ripe red raspberries.

In the long midsummer days, in latitude 52°, there are many hours of daylight, and constant floating would have carried us many miles per day; but frequent stops were made to prospect for fossils, and we rarely covered more than twenty miles per day. High up on the plateau buildings and haystacks proclaim a well-settled country, but habitations are rare along the river, and for miles we floated through picturesque solitude, the silence unbroken save by the noise of the rapids.

During the day an occasional flock of ducks or geese would be disturbed by our approach, though few signs of life were seen along the shore; but among the trees, when the mystic hush of night had stilled the camp, all the underworld was alive, and many little feet rustled the leaves where daylight disclosed no sign of life.

THE NIGHT SOUNDS OF WILD LIFE

Then the muskrat and beaver would take courage to investigate the big intruder of their familiar haunts. From the distance some hungry coyote would send his plaintive cry echoing down the canyon, to be punctuated by the "put-put-put, put, put" of a partridge drumming to his mate, and from the trees above came the constant query, "Who-who—who-who-oo?"

At intervals we would tie up the boat and go ashore to search the banks, that fossils might not be overlooked. No large fossils were found in rocks of the

ANOTHER ANKYLOSAURUS QUARRY

Lowering a 700-pound box, by means of block and fall, to the valley 100 feet below. This specimen included the pelvis, a part of the animal not before known.

Paskapoo age, but as soon as the *Edmonton* rocks appeared in the banks large bones of dinosaurs became numerous, and in the picturesque exposures at the mouth of Big Valley they were especially abundant.

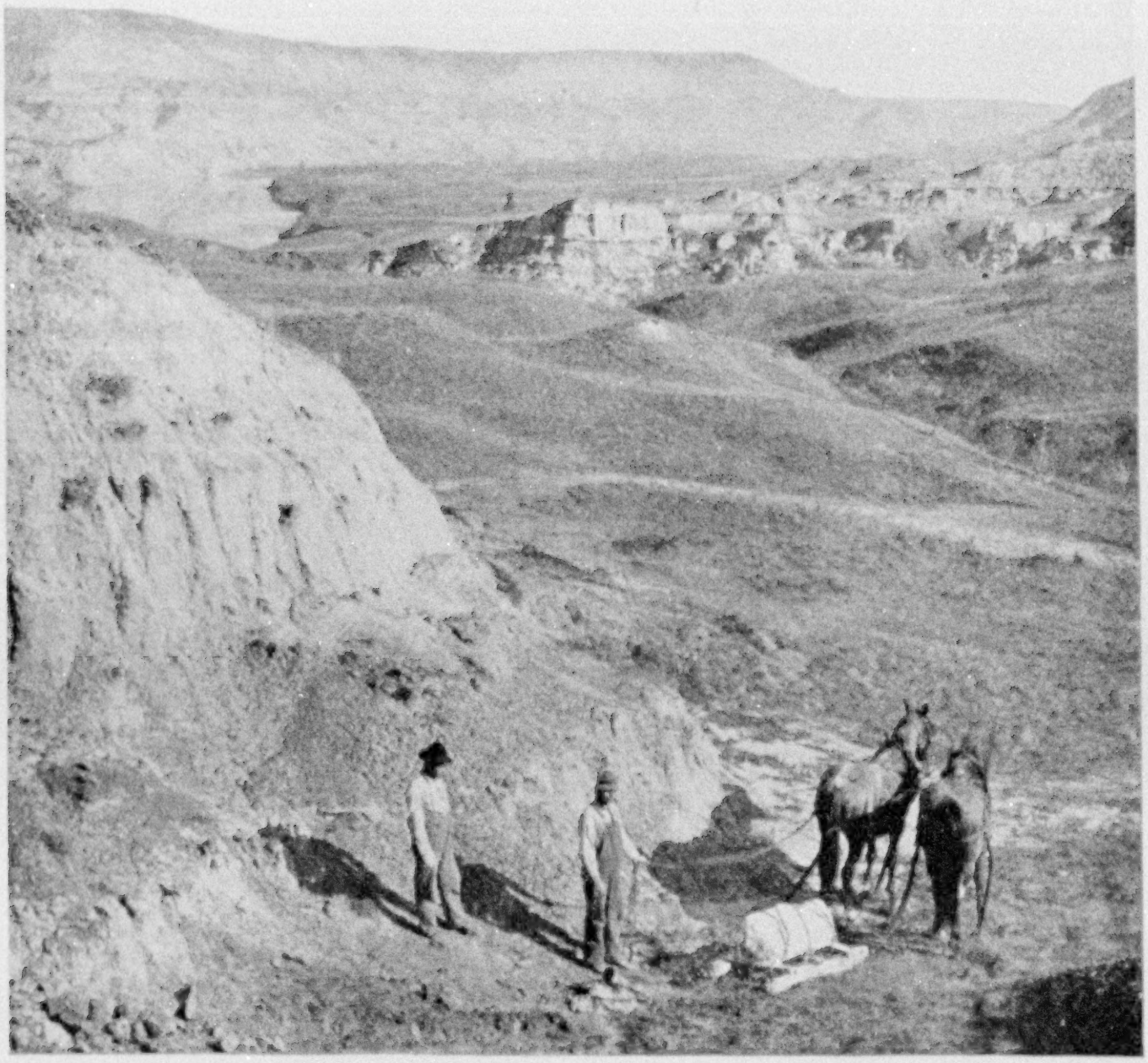
EXCAVATING WITH CROOKED AWL AND WHISK-BROOM

At the foot of a butte lie scattered fragments of bone, and on the rivulet-scarred hillside other fragments appear, as we trace them up the waterways. Finally, ten, twenty, or thirty feet above, other pieces protrude from the bank, and this is our lead. Cautiously we follow in from the exposed surface, uncovering the bone with crooked awl and whisk-broom, careful not to disturb the bone itself; for, although stone, it is usually checked and fractured in many places by former disturbance of its bed or crystallizing of mineral salts, and is rarely strong enough to permit removal.

Other bones may appear in the course of this preliminary work, and, if the find is desirable, the next step is carefully to gather every fragment, large and small, that has weathered out and fallen down the hillside; for when restored in the laboratory one of these pieces may be the critical point in the determination of a species.

Then with pick and shovel the heavy ledges above are removed, and often a team and scraper and dynamite are used when a large excavation is to be made. As we near the bone layer the work is more carefully done, with ever in mind the probable position of the bones of the skeleton. A false stroke of the pick in excavation may cause days of mending in the laboratory and might destroy some delicate bone.

When the bones are uncovered and brushed clean they are saturated with shellac till all small pieces adhere to each other; then the dirt is taken away from



THREE MILES ABOVE TOLMAN FERRY WE FOUND THE HIPS AND PART OF A SKELETON OF A NEW, LONG-SPINED DINOSAUR NAMED HYPACROSAURUS

The hip bones alone weighed 600 pounds and had to be dragged to the river on a sled. It belongs to the family of duck-bill dinosaurs (see page 408).

the sides, more shellac applied, and finally each bone stands on a little pedestal.

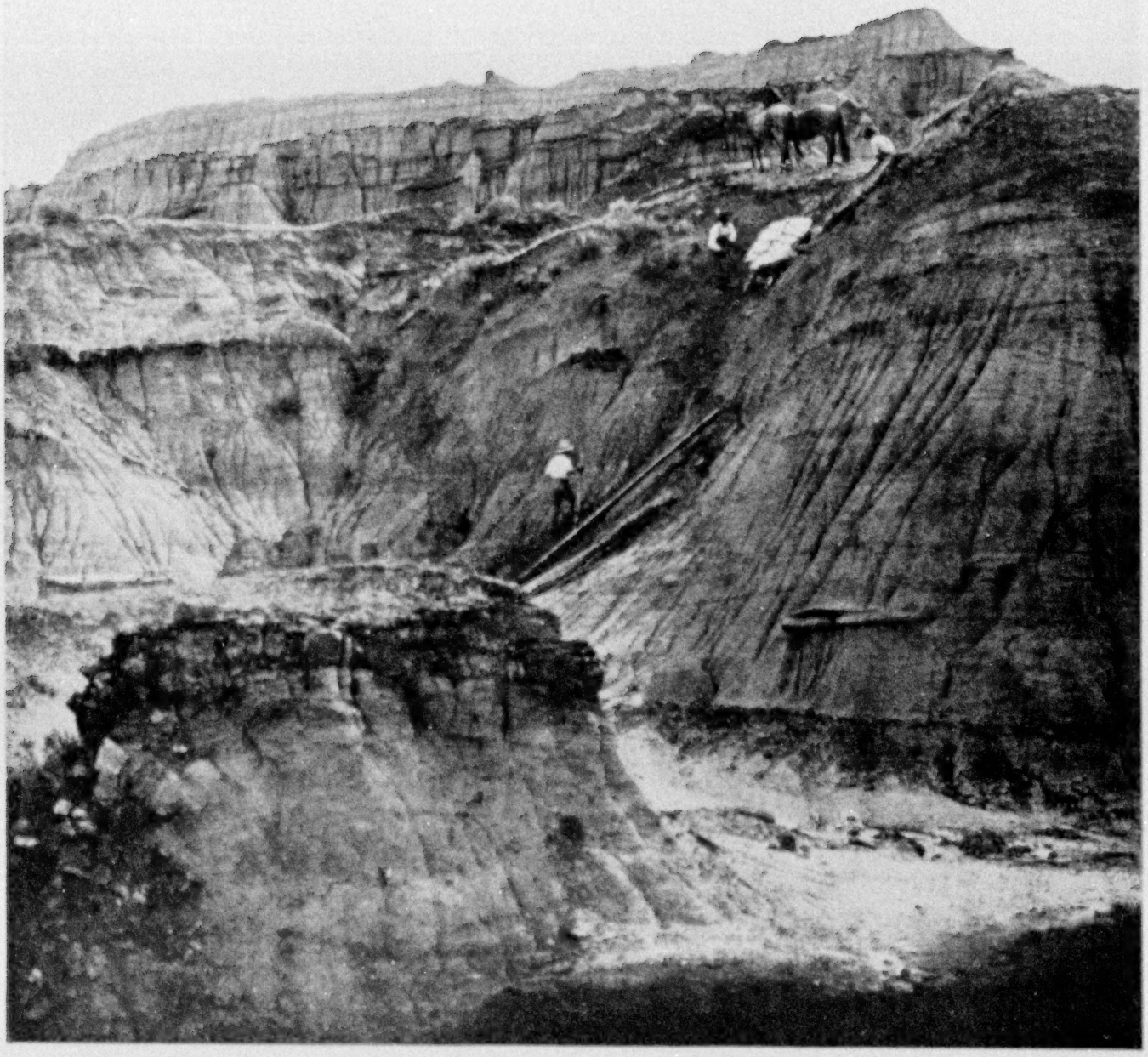
HOW THE MONSTER SKELETONS ARE PACKED

If the specimen is a skeleton, we next determine where the bones may be separated or broken to cause least damage, and each part is covered first with tissue paper, and then with two or three layers of plaster-of-Paris bandages—strips of burlap dipped in plaster. When this is set and thoroughly hard, the block is undermined and turned over and bandages are applied to the lower surface to form a complete plaster jacket.

This preparation is slow and tedious. A skeleton may be uncovered in three days, but it will often take three weeks to prepare it ready for boxing. Then heavy

HAULING THE COLLECTION OUT OF SAND CREEK (SEE ALSO PAGE 416)

Up this converted cow trail a ton of weight may be a big load for six horses. Under the rich, black surface soil, the level prairie lands are composed of sedimentary clays, through which the Red Deer River has cut a miniature Grand Canyon. Although these rocks are of sedimentary origin, they were deposited in ages gone by, when this area was near sea level, while the rivers that are now cutting away the material are of comparatively recent origin.



OFTEN SKELETONS ARE FOUND IN ALMOST INACCESSIBLE PLACES, FROM WHICH THE PREPARED BLOCKS MUST BE DRAGGED ON THE SLEDS AND LOWERED OVER STEEP CLIFFS

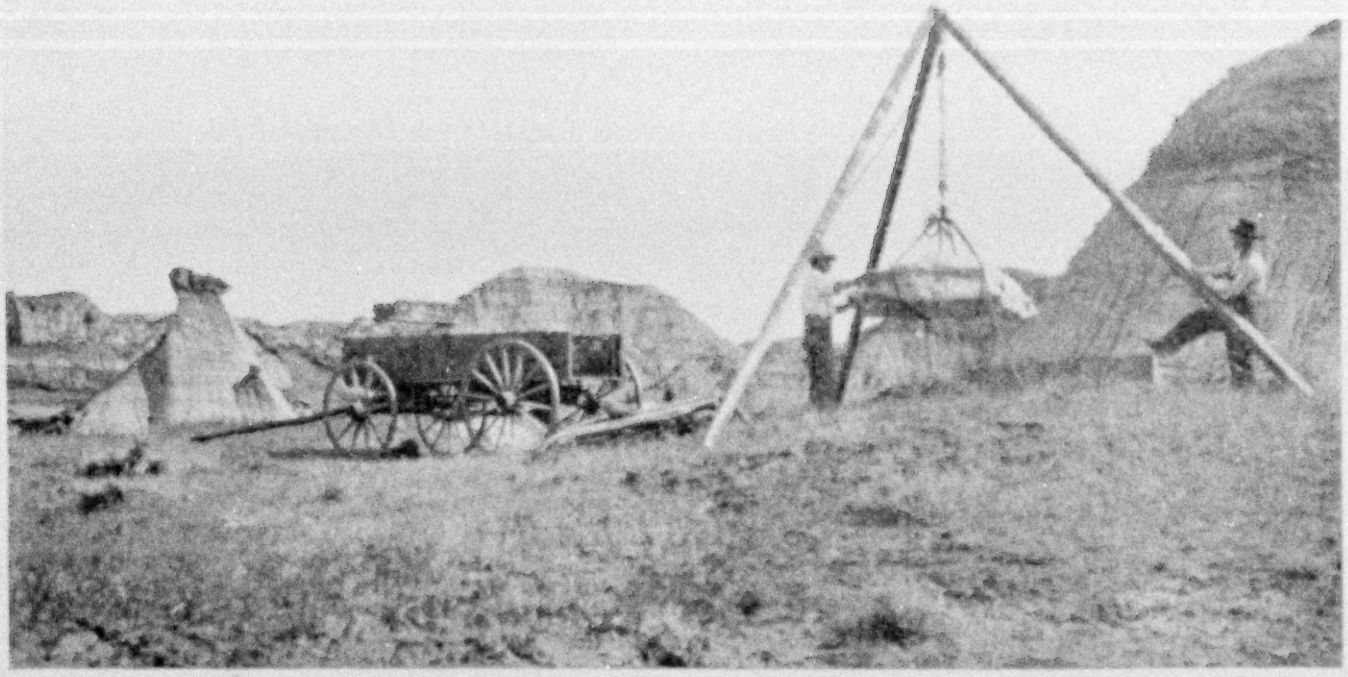
One section of a large carnivorous dinosaur skeleton weighed over two tons. Here a trail had to be made up the steep canyon wall, where a 700-pound box was all that a team could drag on a sled.

boxes are made to dimension for each large block or several smaller ones, and the fossils are carefully packed in hay for shipment to the Museum.

Thus, at Tolman Ferry a few fragments which were seen protruding from a hillside developed into a complete skeleton. At first it was thought to be the well-known "duck-bill" dinosaur *Trachodon*, but when the skull was revealed it was seen to be quite different. It proved to be related, but a form entirely new to science and since named *Saurolophus*, meaning crested saurian, from the long spine extending backward from the top of the head.

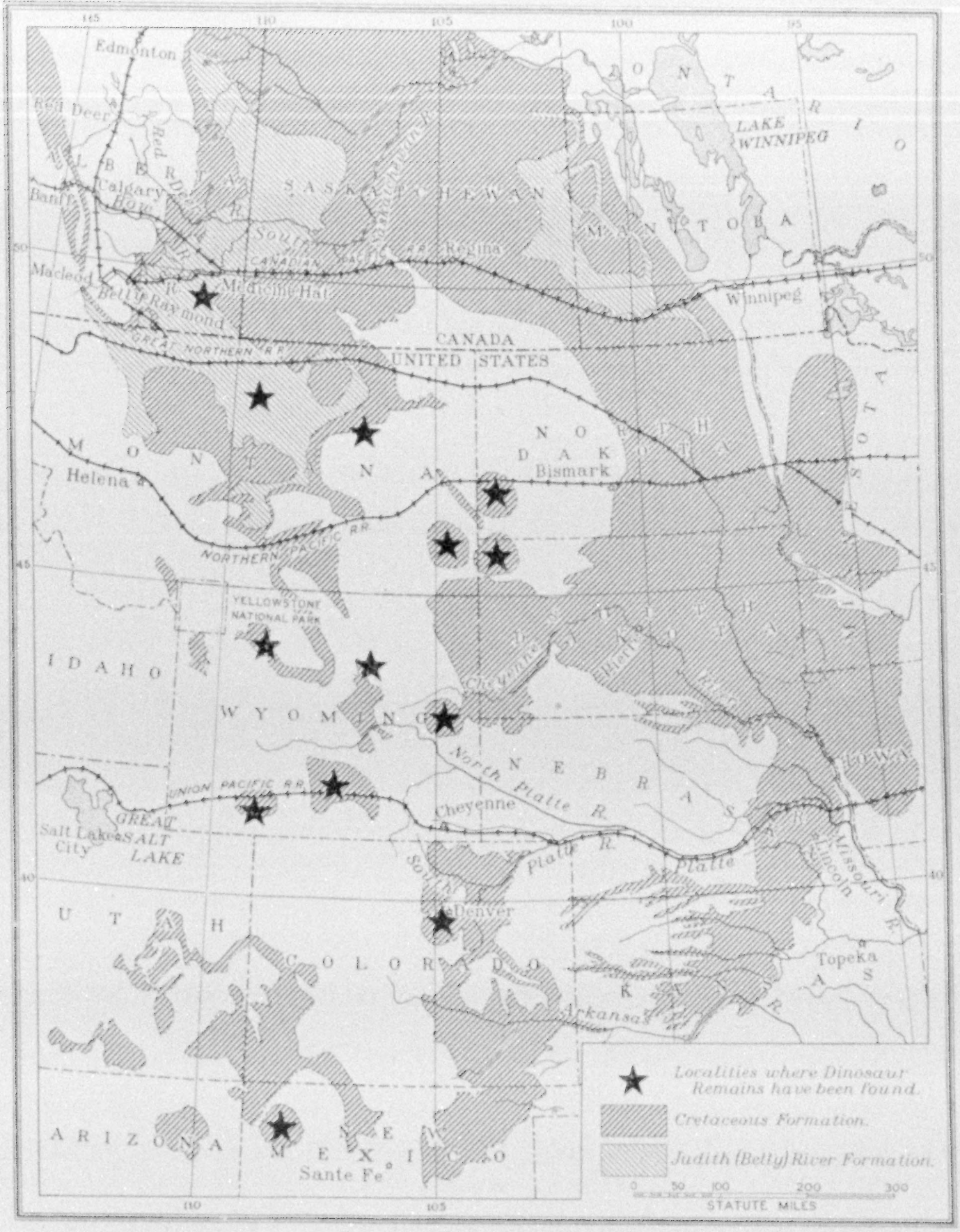
ZEST IN THE HUNT

Today there are thousands of different species of reptiles inhabiting the earth, and during each of the long prehistoric periods there were probably as many or



FREQUENTLY THE PREPARED BLOCKS WEIGH A TON OR MORE, AND IT IS NECESSARY TO HANDLE THEM WITH BLOCK AND TACKLE

HALF-GROWN DUCKLINGS ARE EASILY CAUGHT BY HAND, AND THE EARLY SETTLERS SALTED THEM DOWN IN BARRELS FOR THE WINTER'S MEAT



MAP SHOWING THE LOCATION OF SOME OF THE IMPORTANT FINDS OF DINOSAURIAN REMAINS AND AREAS WHERE DEPOSITS WERE LAID DOWN DURING THE TIME THAT THESE ANIMALS LIVED

The most fertile field for the hunter of big game of other days is a vast area of level land, prairie in the east and forested near the mountains, in the province of Alberta, Canada, between the Great Lakes and the Rocky Mountains, just north of the Canadian boundary. In the lower reaches of the Deer River, which drains a part of this region, sea-shells are found in the rocks, indicating that an inland sea, which extended from the Gulf of Mexico to the Arctic Ocean, once covered this area. When the sea-floor was elevated above the ocean this section became a vast jungle-covered swamp. In these marshes of prehistoric times dwelt a host of reptiles known as dinosaurs (see pages 407 and 409).

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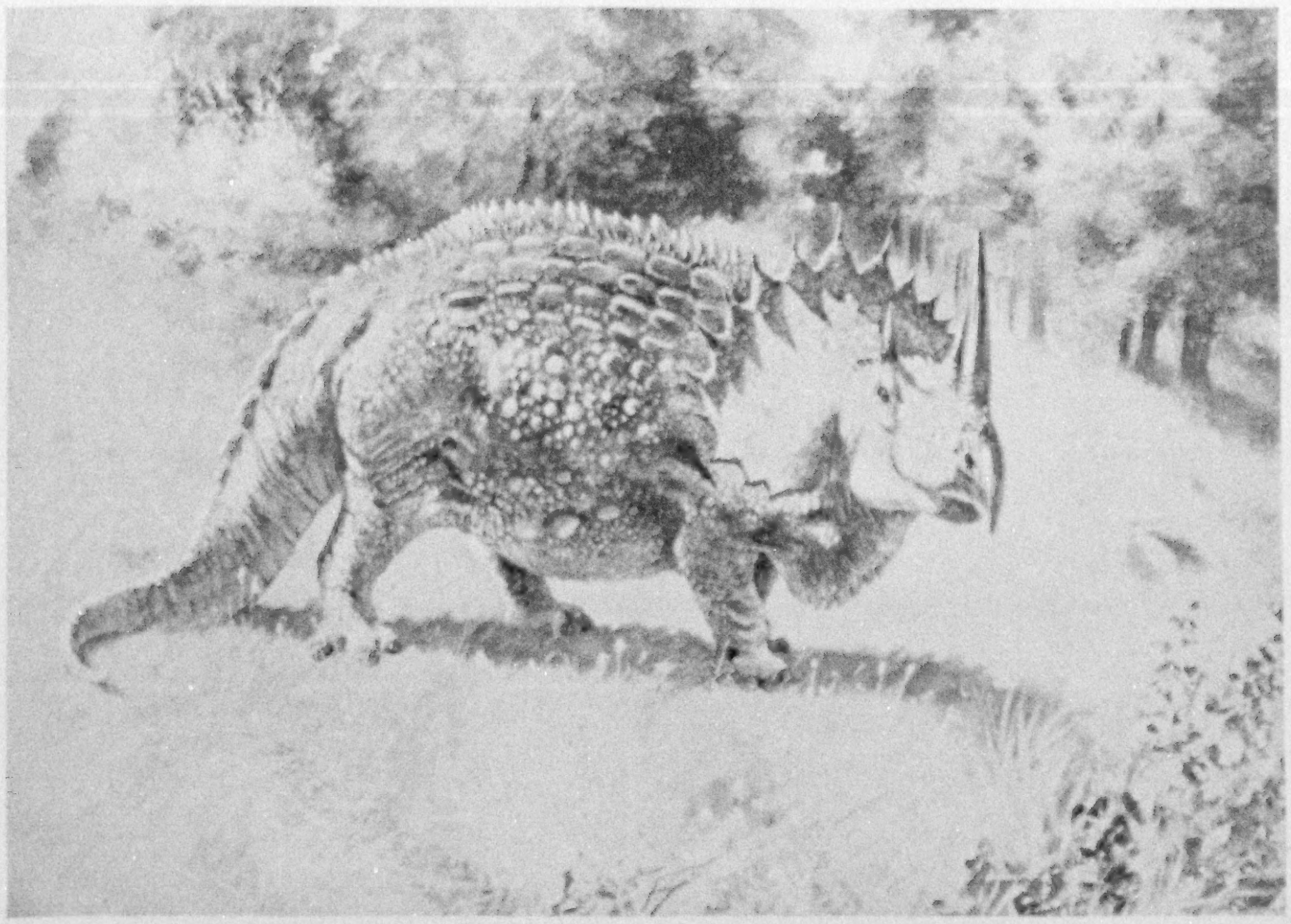

© American Museum

RESTORATION OF MONOCLONIUS MADE UNDER THE DIRECTION OF PROF. E. D. COPE, BY CHARLES R. KNIGHT

This is one of the primitive horned dinosaurs, the Ceratopsia, in which the horn over the nose was largest. In the later members of the family the horns above the eyes are largest (see page 427). Its remains are quite abundant in the Belly River beds.

more different kinds, for reptilian life is now on the wane.

Rarely does a season pass without several new genera being brought to light, and this possibility of discovery of the new and unknown adds zest to an already fascinating field of research. Any prospect may reveal some new creature of bizarre form, and we are constantly finding skeletons of animals known before by parts only.

The *Edmonton* formation has been especially interesting, for at least two-thirds of the species discovered in rocks of that age are new to science.

By the time we had reached Tolman, where a road crosses the river, our flat-boat, piled high with boxes of fossil animals, had become a veritable fossil ark. This was in the latter part of September; thin ice was forming on the river and it became too cold to do further effective collecting. The boat was then beached for the winter and the collection shipped back to the Museum.

Each summer work has been continued from the point at which it ceased the year before and the search has been carried on thoroughly.

Elsewhere complete dinosaur skeletons are rare, but in this part of Alberta they are not uncommon. In no other part of the world have so many Cretaceous dinosaur skeletons been brought to light. One American Museum Expedition collected eight skeletons from a limited area exposed along three miles of the Red Deer River.

CAMP LIFE WHILE ON THE HUNT

Searching for prehistoric animals by boat is even more interesting than similar work in the arid "Bad Lands" of the plains. Those who have husbanded drinking water on the desert through long hot summers keenly appreciate a river of snow water.

Pike, pickerel, and sturgeon are caught in the Red Deer, and the persistent angler never fails to land a few "gold-eyes," a

After U. S. National Museum, from a drawing by Charles R. Knight

THIS EXTRAORDINARY DINOSAUR (TRICERATOPS, UPPER CRETACEOUS, NORTH AMERICA) WAS A STRICTLY LAND FORM AND GREW TO A LARGE SIZE—25 FEET IN LENGTH

The head, with its accompanying neck frill, was enormous—8 feet in length in the large specimens. The creature was herbivorous, the jaws containing many fine teeth, evidently used in crushing vegetable food. The enormous horns grew upon a bony cover, as do the horns of a cow, and the upper jaws ended in a horny, turtle-like beak. The two erect dinosaurs in the background are Trachodons, a contemporaneous species (see page 408).

species of fresh-water herring delicious when properly baked.

After a long day's search along the face of the hillsides or work in the quarry, the collector returns to camp hungry and exhausted, but soon to be revived by a good camp supper. Then the hour before sundown is spent with rod or motor-boat. The winds have ceased, and as the sun disappears over the rim, long purple shadows conjure fantastic forms on the rugged canyon walls; then a cheerful camp-fire, pipes, and stories of other days and scenes.

All, of course, are not roseate scenes. The particular fly in our ointment has been the mosquitoes, which last year flocked to anything that moved, in numbers that I hesitate to estimate. But to the lover of camp life the days of discomfort and privation are those soonest forgotten.

As a result of the past four years' work in Canada, the American Museum Expeditions have collected 300 large cases, or three and one-half carloads of fossils, two-thirds of which are exhibition specimens, including twenty skulls and fourteen skeletons of large dinosaurs, besides many partial skeletons. This material represents many genera and species new to science, and defines the anatomy and distribution of several heretofore but partially known creatures.

But the field has by no means been exhausted. Under miles of prairie land the same strata are undoubtedly filled with similar fossils; erosion is rapid, and as the river continues to wear its banks away new fossils are exposed. In a few years the same territory can be explored with similar results, and for all time to come the Red Deer River will be a classic locality for collecting prehistoric treasures.

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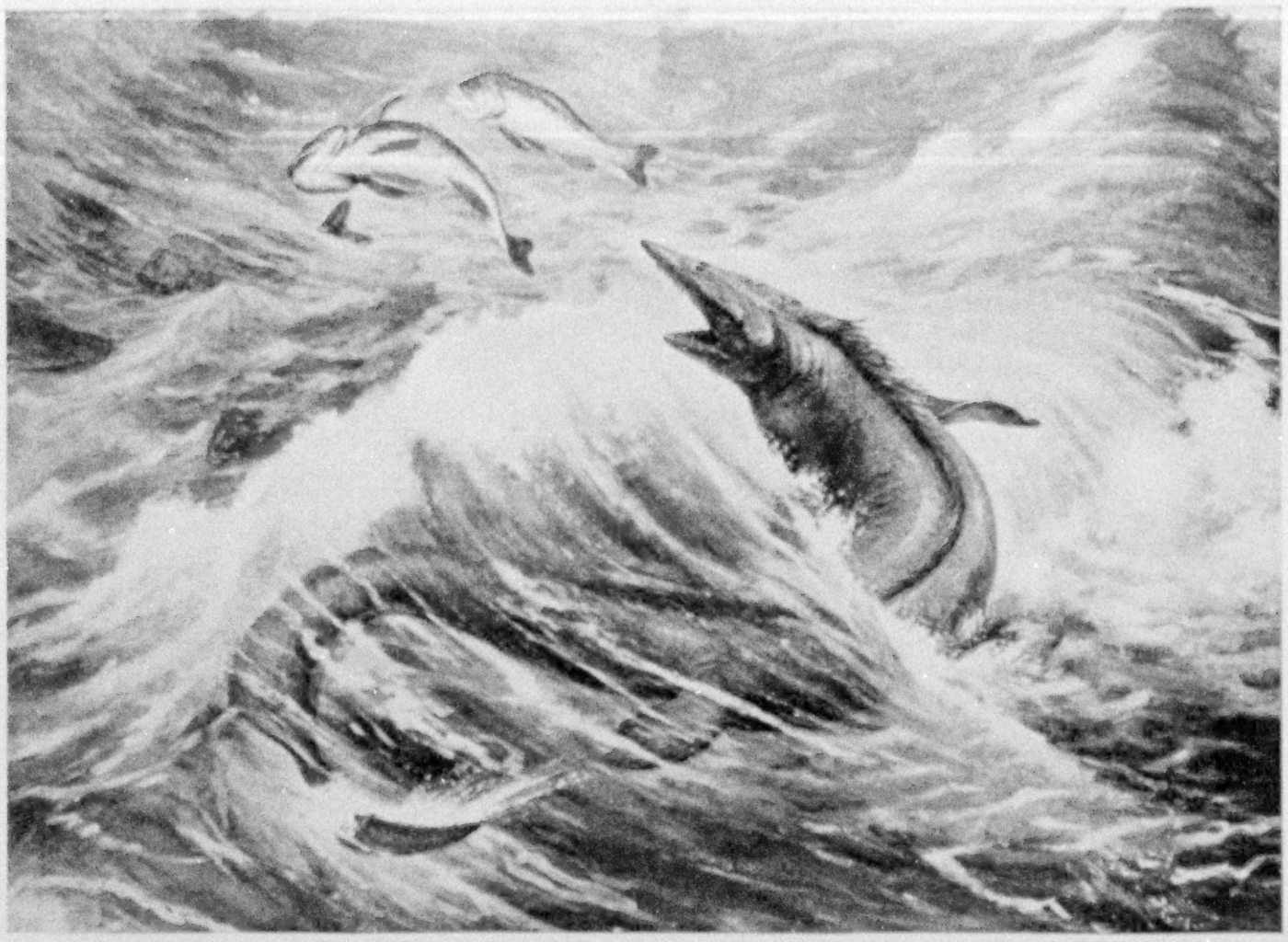
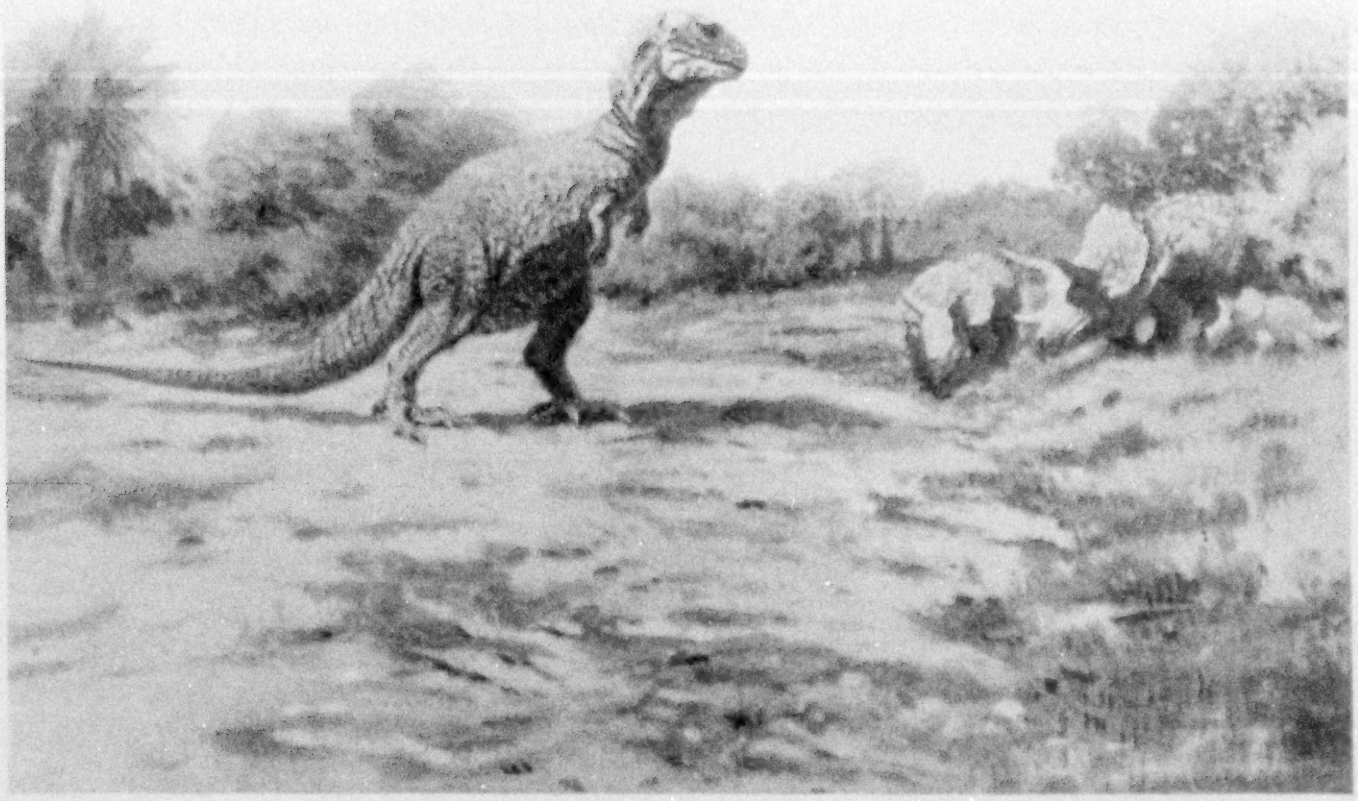


A GREAT MARINE LIZARD-LIKE FORM FROM THE KANSAS CHALK

The long and powerful jaws were armed with numerous sharp teeth and the limbs were developed into short paddles. The specimen here shown is some 30 feet in length and was found in almost perfect condition.

A SMALL, ACTIVE DINOSAUR, ABOUT FIVE FEET IN HEIGHT, FOUND IN WYOMING

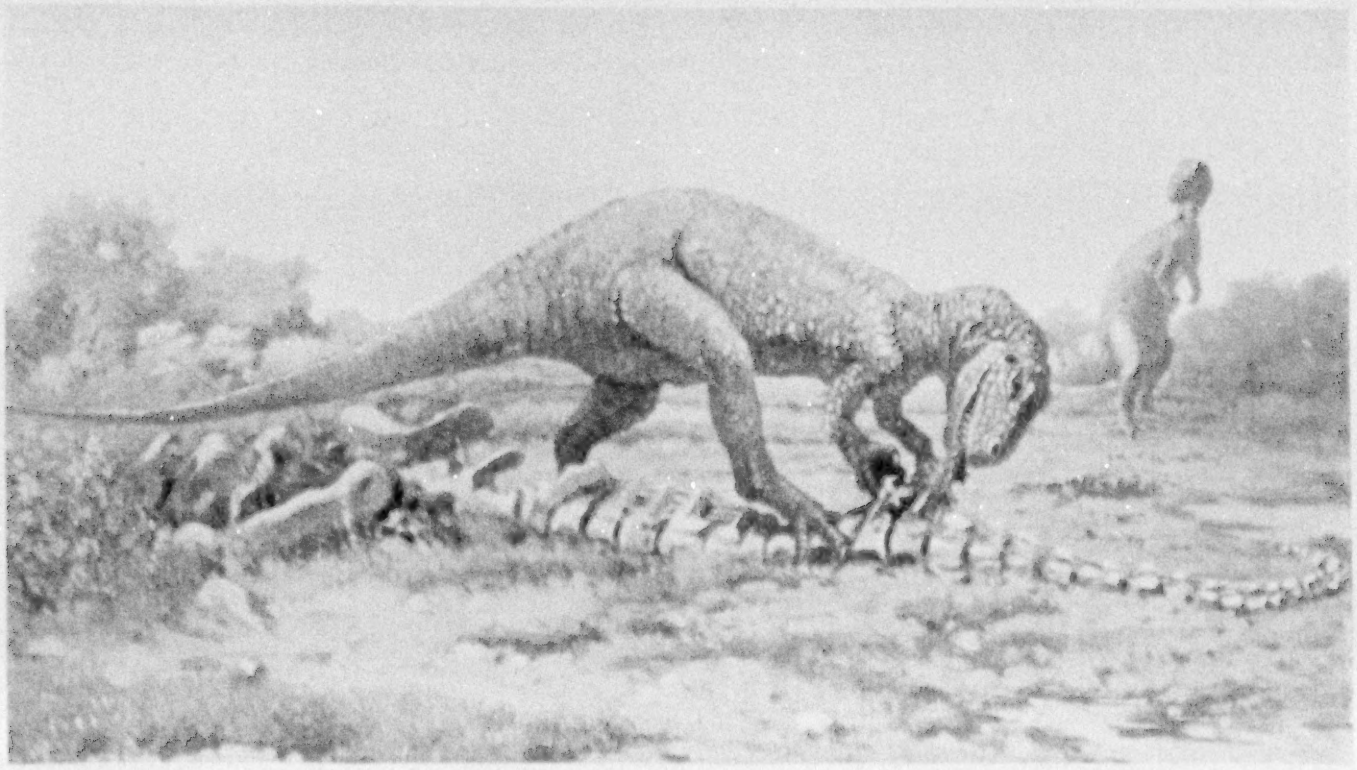
The picture shows one capturing an ancestral bird whose jaws contained sharp teeth like those of a lizard.



After Osborn, from a drawing by Charles R. Knight

THIS FORMIDABLE DINOSAUR, THE LARGEST OF THE CARNIVOROUS FORMS, WAS SOME 40 FEET IN LENGTH (SEE PAGE 413)

It must have presented a most imposing sight as it stalked about in search of food. The great 5-foot jaws were armed with long and sharp teeth, capable of tearing the tough skins of such antagonists as the great Triceratops of the same period (p. 408). This latter creature could not escape by running away, and so was forced, no doubt, to back into some dense forest growth whenever possible, presenting merely its sharp-horned head to its adversary.



After Osborn, from a drawing by Charles R. Knight

THIS GREAT CARNIVOROUS DINOSAUR HAS BEEN KNOWN FOR SOME YEARS PAST, BUT ONLY RECENTLY HAS A COMPLETE SKELETON OF IT BEEN PLACED ON EXHIBITION

The creature is depicted feeding upon the remains of a Brontosaurus, whose actual vertebræ, chiseled by the sharp teeth of some similar creature, are placed beneath the mounted skeleton in the American Museum.

XUM

INDIANA'S UNRIVALED SAND-DUNES—A NATIONAL PARK OPPORTUNITY

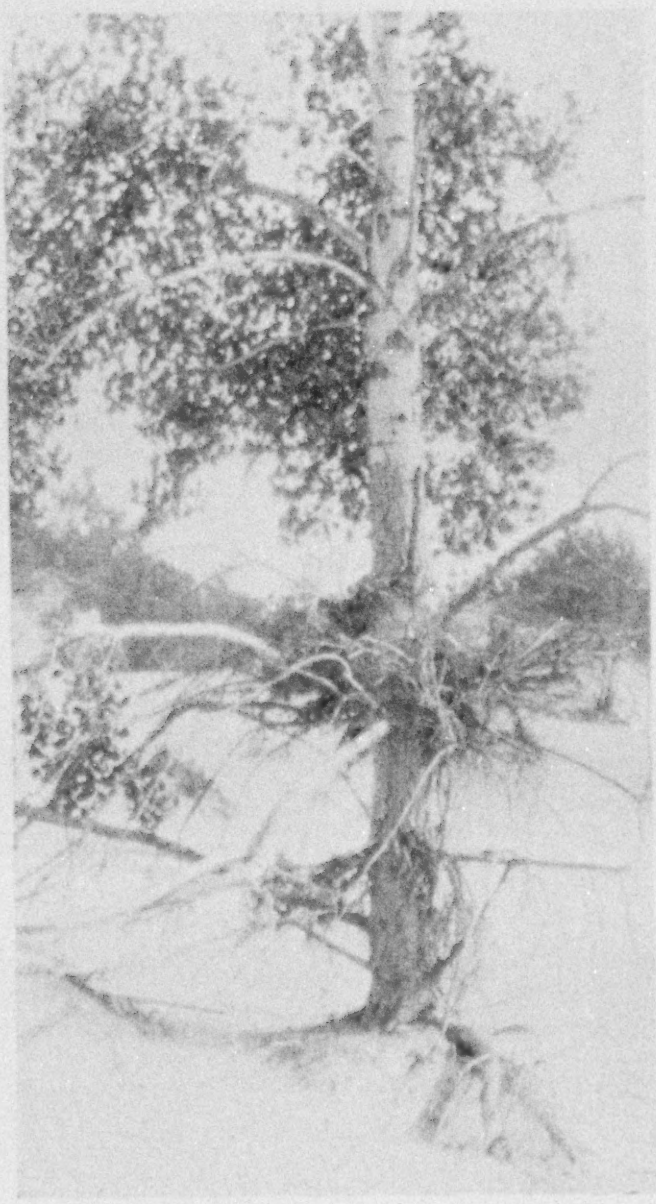
By Orpheus Moyer Schantz

A DUNE region ordinarily signifies an inhospitable, wind-swept tract of country, barren of vegetation and sparsely inhabited by animal life. The term "sand-dune" long ago denoted a land to be avoided by travelers whenever possible. Lack of water, intense heat, and the ever-drifting sand itself were sufficient causes for shunning any dune country as a highway. Charles Kingsley, in Westward Ho, says: "The Spaniards neared and neared the fatal dunes that fringed the shore for many a weary mile."

The dunes of the Atlantic coast, driven inland by the terrific storms off the ocean, at times have devastated large areas of fertile land, relentlessly destroying all vegetation, and the dune regions of interior America were the bane of early pioneers.

At the head of Lake Michigan, including the entire shoreline of Indiana and parts of the adjoining shores of Illinois and Michigan, there is a dune country, unique and wonderful and entirely different from our usual ideas of sand-dunes.

The vegetation of the average desert or sandy region is usually an interesting example of the survival of the fittest, and most of the plant families remaining have adapted themselves to the severe



Photograph by Frances La Follette

A POPLAR WHICH CONVERTS ITS BRANCHES INTO ROOTS AND ITS ROOTS INTO BRANCHES, AS THE WIND BLOWS

At one time this tree of the Indiana sand-dunes was buried up to the dark line. The limbs then did duty as roots, but now that it is being uncovered they are again performing their normal function as limbs.

Photograph by J. R. Daniels

A FIND FOR THE ORNITHOLOGIST

He sits and blinks the day away amid trees and shrubs of bewildering beauty growing on the shores of a fresh-water sea.

Photograph by H. Mertsky

THE OUTLINES OF THE DUNES ARE ALWAYS GRACEFUL

Their size is indicated by comparison with the human figure. The lake appears in the distance.

Photograph by Alfred L. Fitch

UP HILL AND DOWN DALE IN INDIANA'S COMBINATION DESERT AND OASIS

The verdure-clad billows of sand constitute a veritable botanical garden, which is a paradise for birds and plants of many species.

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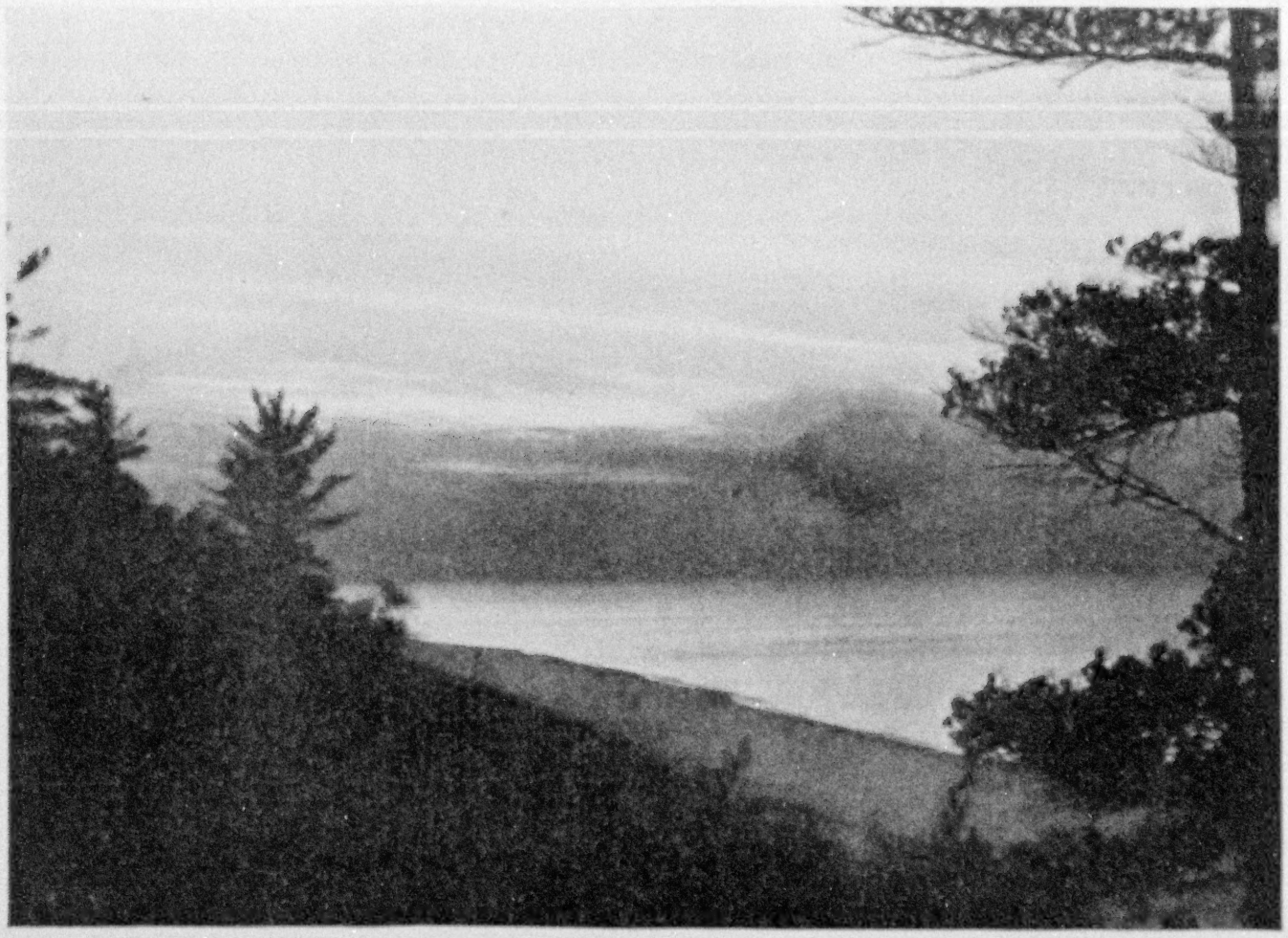


Photograph by Arthur E. Anderson

AT THE HEAD OF LAKE MICHIGAN THERE IS A DUNE COUNTRY UNIQUE AND WONDERFUL

It includes the entire shoreline of Indiana and parts of the adjoining shores of Illinois and Michigan.

Photograph by A. E. Ormes

A WINTER LANDSCAPE IN THE DUNES

Photograph by Irwin S. Rosenfels

THE INDIANA SAND-DUNES AND LAKE MICHIGAN SHORE

conditions of their environment. Desert plants, too, are often strikingly beautiful when in blossom; but their period of growth and luxury is very short, lasting only through the rainy season.

A SEA OF SAND, BUT NO DESERT DROUGHT

Conditions are reversed in the Indiana dunes, for here there is never a long period of drought, and in place of a desert area there is a natural propagating garden, where a most astonishing number of rare and beautiful plants congregate, having migrated both from the north and south to this unusually favored locality (see pages 434-435).

Here, on the shores of a great fresh-water sea, whose moisture is constantly being carried southward by the prevailing northwest winds, and tempered both in summer and winter by its position on the lake, is a region so wonderful that it should be kept for all time as a great natural park for study and the recreation of millions of people of the Middle West.

There are about 20 miles of shoreline, averaging a mile or more in width and containing approximately 30 square miles of land in the dunes, still unspoiled by commercial industries. This region is situated within easy reach of more than 10,000,000 people at a nominal cost for transportation.

A visit to almost any one of the national parks is a luxury beyond the reach of the majority of the people of the Middle West; but the Lake Michigan dune region can be visited at all seasons and at a cost of, at the most, a few dollars. The dunes are popular even in mid-winter, and many a party of students and other outdoor enthusiasts has enjoyed the scenery and the bracing air of the lake at that time of year (see pages 437, 440).

MANY CHARMS FOR MANY MEN

The attractions of the dunes are so varied that all classes may here find recreation suited to their wishes. The tramper, the geologist, the botanist, the zoölogist, the student of early American history, and those who seek only fresh air and clear skies, can find all they desire, and more than they hoped for, in

XUM

Photograph by H. Mertsky

AMONG THE LUPINES IN THE SAND-DUNES

Great masses of bird's-foot and other violets, lupines, phlox of different colors, trilliums, waxy bells of wintergreen and blueberry, hepaticas, trailing arbutus—not just a few flowers, but acres of them and miles of acres—make a natural flower garden which cannot be duplicated artificially.

Photograph by L. T. Gable

WHERE THE WAVES BREAK UPON THE DUNES OF INDIANA

Canoeing here resembles the exhilarating sport of surf-board riding in the Hawaiian Islands.

Photograph by Arthur E. Anderson

THE TOPOGRAPHY OF THE DUNES LENDS ITSELF TO THE FORMATION OF MARVELOUS PLANT SOCIETIES

this wonderland of sandy beach and forested lake shore.

The outlines of the dunes are always graceful; for Nature, though sometimes cruel, displays wonderful skill as an artist, and the exposed wind-carved sands are arranged in beautiful curves and outlines against the sky.

The topography of the dunes lends itself to the formation of marvelous plant societies: great shallow ponds, with their typical borders of marsh-loving plants; deep, sheltered hollows, perfectly dry at the bottom; active stream beds, thickly fringed with willows, alders, and buttonbush, with thickets of giant mallows on the mucky shores; north slopes, with trailing arbutus, wintergreen, partridge berry, hepaticas, and violets, and rare ferns and orchids spread in artistic profusion; moving dunes, whose leeward sides extend slowly and surely south, in time covering even tall trees, with their smothering blanket of sand; old dunes, clothed to their crests with vegetation, and at intervals "blow-outs," where reverse winds have uncovered ghostly tree trunks, gray and weather-beaten and entirely denuded of bark, but the wood still sound and perfectly preserved by the sand shroud with which it was surrounded.

PLANT LIFE OF MARVELOUS VARIETY

Many trees adapt themselves to the severe conditions on the more exposed dunes, frequently sending out roots from the trunk to take advantage of the encroaching sand, and if again uncovered the roots immediately function as branches. This is particularly true of the cottonwood, which also sends out roots of remarkable length close to the surface of the sand, in this way making use of surface moisture (see page 430).

Trees, shrubs, and many plants from the far north grow side by side with others whose natural habitat is many miles south of the lake, and the plant life is bewildering to the uninitiated and a joy to the botanist. The combination of underlying sand and humus, with abun-

XUM

Photograph by Frances La Follette

SAND-DUNE WOODLANDS IN WINTER

Each succeeding season among the dunes brings its pictures of natural beauties and scenic charms.

dant moisture, makes a condition of soil that is ideal, and the result is a luxuriant plant growth that is almost tropical.

The dune-floor vegetation is more striking than the arborescent growth, and the wealth of herbaceous plant life is remarkable. Even on the exposed lake beach and on newly formed sand drifts pioneer plants are constantly springing up. Hardy grasses, sea rockets, artemisias, sand cherries, and many others take advantage of the slightest opportunity, and around these plants embryo dunes form, which in time grow and join the ever-changing and fascinating panorama of dune succession.

As soon as a slight covering of humus accumulates, possession is taken by the stronger plant growth, and bearberry, juniper, arrow woods, and sumacs soon fill up the vacant spaces, preparing the way for the tree growth that is waiting its turn.

The black oak is the most conspicuous tree of the older dunes, but it is accompanied by many others, mostly deciduous, although there are a few evergreens and one other conifer—the tamarack.

Basswood, poplars, tulip, sassafras, juneberry, flowering dogwood, white and gray pines, and occasionally white oaks, are all to be found in the drier parts of the dunes; and in the lower lands sour gum, red maple, swamp white oak, pawpaw, cherry, and the larger sumacs grow luxuriantly in the peaty soil.

A NEW GREEN FOR EVERY SEASON

Each season in the dunes has its own individual attraction. In springtime the dark greens of pines and junipers make a fitting background for the delicate shades of the opening foliage of the deciduous trees, with their soft greens, pinks, and reds. Great splashes of white blossoms of shad bush, cherry, plum, and viburnums; the striking blossoms of flowering dogwood and button bush; masses of red maple pendants and the delicate coloring of the oaks make a strong appeal to the esthetic sense of the lover of Nature.

Over all the taller growth are scattered draperies of vines, softening the rigid outlines and adding their blossoms to the marvelous display.

The herbaceous plant life is even more varied and wonderful. Great masses of bird's-foot and other violets, lupines, phlox of different colors, trilliums, waxy bells of wintergreen and blueberry, hepaticas, trailing arbutus—not just a few flowers,

but acres of them and miles of acres—make a natural paradise which cannot be artificially duplicated (see page 434).

The marshes have their own individuality of sedges, cat tails, reeds, and borders of the larger ferns—royal, cinnamon, and interrupted. The Virginia chain fern in one of the drier marshes crowds out the less vigorous plant life, coloring with its fertile fronds great stretches of the marsh a beautiful sepia. The blending of browns and greens in the marshes softens the landscape to an exquisite symphony of color in pleasing contrast to the more vivid coloring of the higher land adjoining.

AUTUMN'S FLAMING DUNE LANDSCAPE

It is in autumn, however, that the dune coloration is at its best, for then the entire region becomes a flaming landscape of gorgeous reds and yellows. Nature goes into her winter rest with a last effort in color that is beyond adequate description. The sour gum, red maple, sumacs, and sassafras discard their modesty and vie with each other in a gorgeous riot of autumn coloring. The foliage of the black oak, as it changes, combines red, green, and bronze, and covers the ridges with a garment of beauty.

Photograph by Frances La Follette

THIS IS A SAND-DUNE COVERED WITH SNOW

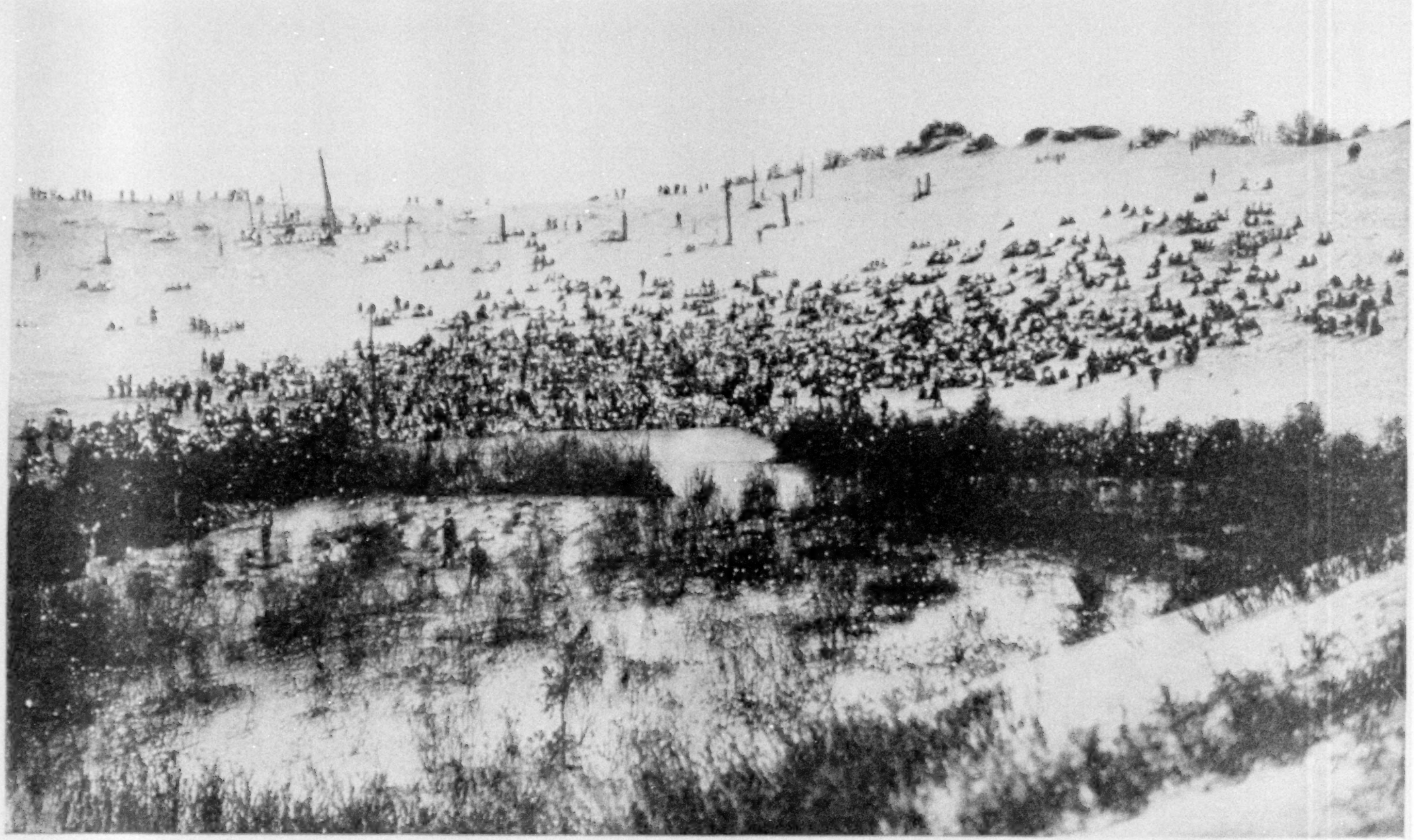
The dune country, easily accessible to 10,000,000 Americans, has its special lure for every month of the year.

Many of the trees and lesser shrubs and other plants bear edible fruits, providing a sumptuous larder for hosts of birds and small animals. The bird life of the region surrounding the end of Lake Michigan is very abundant, and during migrations nowhere in the United States are there more varieties of both land and shore birds to be seen than here.

Conditions of food, shelter, and climate are particularly favorable for these visitors. Although the game birds are sadly persecuted, they still visit the dunes in great numbers each year, scarcely a season passing without having among its records some rare migratory visitor or new nesting record.

The ruffed grouse, golden eagle, horned owl, and the great blue heron still visit the dunes, and in winter-time the evening grosbeak, crossbills, and pine finches are attracted by the wealth of food.

Geologically, the dunes and distinctly traceable old shorelines tell the fascinating story of the Glacial period antedating Lake Michigan. The near-by universities bring their classes to the dunes



Photograph by H. P. Cook

THE SCENE OF A PAGEANT PORTRAYING THE EARLY HISTORY OF THE INDIANA SAND-DUNES

This pictorial presentation of the events which made this region a part of the American Union was fittingly staged in a natural amphitheater formed by the dunes themselves. It was through the dune country that the French pioneers found their way from Detroit to the site of Chicago.

Photograph by Irwin S. Rosenfels

DOWN MOUNT TOM: INDIANA SAND-DUNES

as a most necessary object-lesson of their natural-science courses.

HISTORIC ASSOCIATIONS IN THE DUNE COUNTRY

Historically, also, the dunes have their place in the earlier history of the West. The old Indian trails can still be pointed out, and it was through the dunes that the pioneer French found their way from Detroit to the site of Chicago, at the mouth of the Chicago River.

Nature organizations of Chicago and Indiana have done much to bring the dunes to the attention of thousands of people who never before knew them except superficially from the railroad or trolley line, and each year they are becoming better known and appreciated.

As a result of this education the residents of the adjacent country are beginning to realize that they have a truly remarkable forest area within a few hours' ride; that miles of beautiful beaches are free to the tired city dweller, and that here they can go out in the pure air and see the sun rise and set over the lake, without a sign of skyscraper or factory visible anywhere.

The consideration of the dunes as a national park has received the serious attention of Congress to the extent that in 1916 a public hearing was held in Chicago to gather data in connection with the proposed project. At this hearing hundreds of men and women of prominence gave evidence as to its advantages.

In the spring of 1917 a pageant was given in a great natural amphitheater in the dunes, which vividly portrayed the early history of the dunes, illustrating with striking exactness the stirring events which made it American.

SHALL THEY BE PRESERVED?

The interest of the public in the dunes has been materially advanced by the public hearing and the great pageant, and a new epoch has been reached in the campaign for their preservation. If this re-

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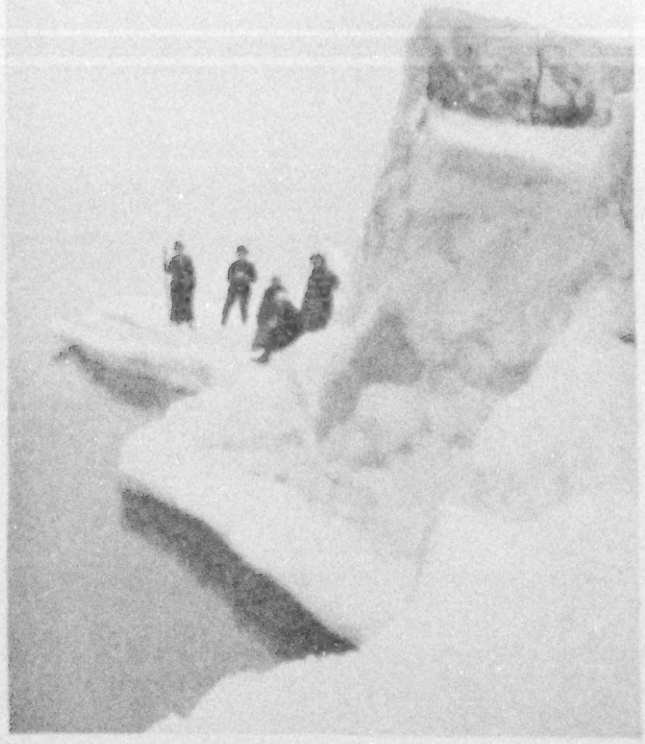
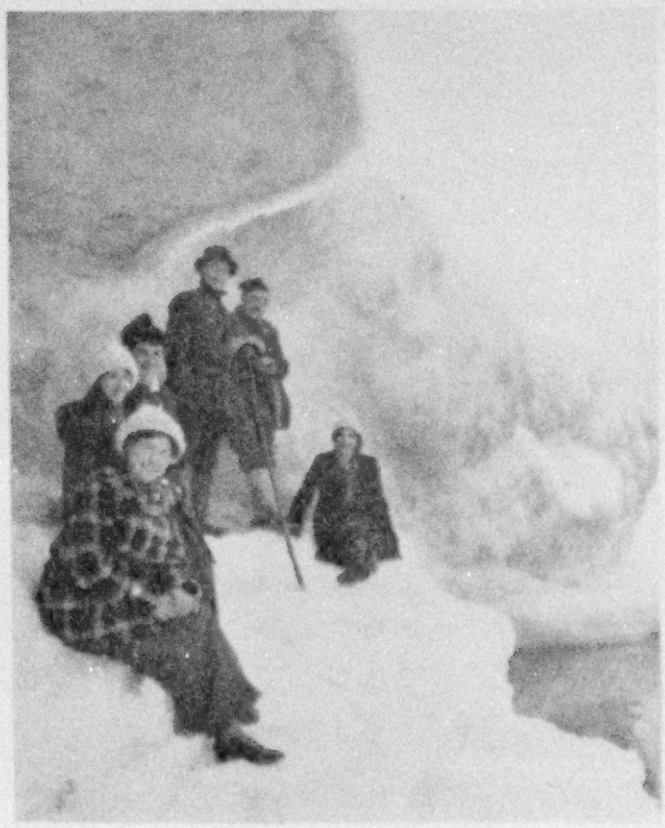
WHEN ARCHITECT WINTER BUILDS AMONG THE SANDS



YOU MIGHT BE WITH PEARY, BUT IT IS ONLY THE DUNES



IN THE "HIGH ALPS" OF THE DUNES

AN ICE BRIDGE ALONG THE DUNES

The snow king converts the southern shores of Lake Michigan into the semblance of Greenland's icy mountains. Photographs by C. G. Dudley.

gion is allowed to pass into the hands of commercial industries, the people of the State of Indiana and of the entire country will lose for all time their free access to Lake Michigan.

The importance of prompt action cannot be urged too strongly, as the demand for large tracts of land with railway and water facilities would soon result in the destruction of the natural advantages of this remnant of scenic beauty and fascinating forest and plant life.

Under commercial occupancy the growth of centuries could be destroyed in a short time. It would be a catastrophe if this opportunity for preserving an incomparable breathing spot on Lake Michigan should be neglected.

HELIUM, THE NEW BALLOON GAS

By G. Sherburne Rogers, Ph. D.

Of the United States Geological Survey

HELIUM, the new incombustible gas which promises to revolutionize the science of ballooning, appears to be the latest addition to the long list of natural products with which the United States is bounteously endowed. In fact, the only workable supplies of the gas that have yet been discovered anywhere in the world are found in the United States, and this country thus has a powerful advantage in the competition for supremacy in the air which the next decade is bound to witness.

The history of helium, which derives its name from the fact that it was first discovered in the sun—almost 30 years before it was identified on earth—and which was later found to be related to that most precious and wonderful of all elements, radium, is in itself of interest; but the discovery of the supposedly rare helium in ordinary natural gas by one scientist, the conception of another that helium would be ideal for inflating balloons, and the labors of still others in devising methods for extracting it from natural gas and in locating supplies adequate for this country and its allies, form an interesting chapter in the account of America's contribution to the war.

The qualities of helium that make it so valuable for use in balloons are its lightness and its incombustibility. Helium is the lightest of the so-called inert gases, which do not combine with oxygen or any other substance and therefore cannot explode or burn.

Hydrogen, the gas commonly used in filling balloons, is, on the other hand, highly inflammable. Many a great balloon, or rigid airship, costing thousands or hundreds of thousands of dollars to construct, has been destroyed by fire in a few minutes—some by lightning, some by sparks from the motor, and others by any one of the numerous accidents that may happen even when the craft is in its hangar.

WEAKNESS OF HYDROGEN-FILLED BALLOONS

In military balloons or airships the fire hazard is, of course, greatly increased, a single well placed incendiary bullet being sufficient to transform the whole costly structure into a mass of flames; and in this event the fate of the crew is practically sealed. This weakness, inherent in all hydrogen-filled balloons, was not only a potent factor in the practical failure of the German Zeppelin program, but has always been a drawback to the development of lighter-than-air craft.

With the fire hazard completely eliminated by the use of helium, however, the risks of ballooning are greatly decreased and many new possibilities open up. The power plant of the airship may be placed as close as desired to the great gas bag without fear of sparks, and by thus making the design more compact, and so re-

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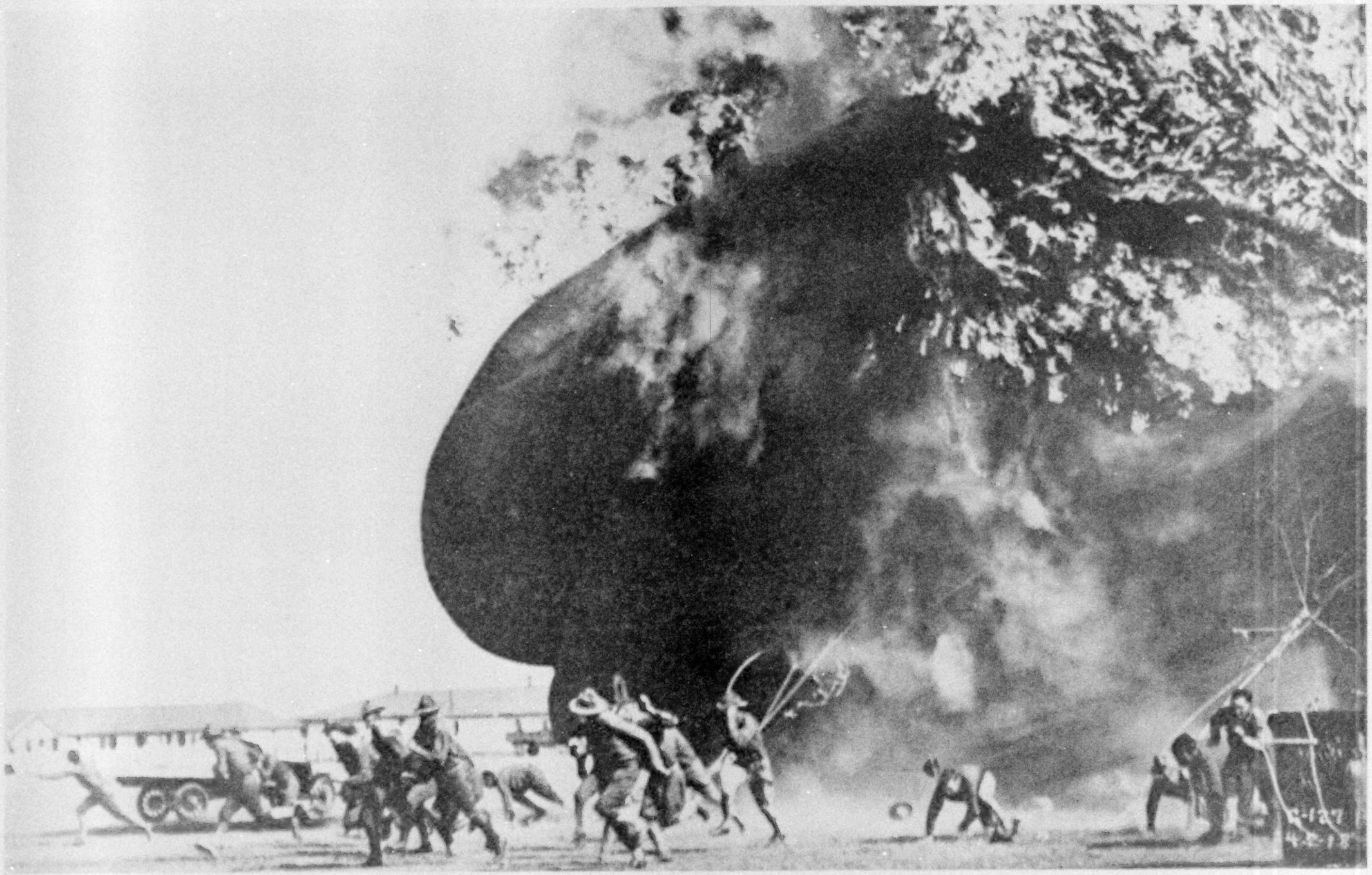

Photograph courtesy Division of Military Aëronautics

EXPLOSION OF A HYDROGEN BALLOON, FORT SILL, OKLAHOMA: SUCH AN ACCIDENT WOULD HAVE BEEN IMPOSSIBLE HAD THE GIGANTIC BAG BEEN FILLED WITH NON-INFLAMMABLE HELIUM

In peace as well as in war any one of a score of mishaps can cause such a catastrophe, so long as hydrogen is used as the buoyant gas for dirigibles. A defective electrical connection, a spark from the wireless apparatus, a stroke of lightning, or an incendiary bullet in time of war are some of the agencies of destruction.

XUM

Photograph courtesy Division of Military Aeronautics

ALL THAT IS LEFT OF A HYDROGEN BALLOON AFTER THE EXPLOSION SHOWN ON THE PRECEDING PAGE

ducing the wind resistance, the speed and cruising radius of the craft may be materially increased.

MACHINE-GUNS CAN BE MOUNTED ON TOP OF HELIUM AIRSHIPS

In military airships machine-guns may be mounted directly on the envelope instead of being tucked away in the gondolas, as far as possible from the dangerous gas; and, on the other hand, all danger of attack with incendiary bullets disappears. This is not simply theory; tests have been conducted on model balloons filled with helium, and all efforts to explode them or bring them down with incendiary bullets failed.

There is always a chance in a thousand that an anti-aircraft shell might explode directly within the envelope, and it might also be possible to bring down a helium-filled balloon by driving an airplane through it bodily, but otherwise it would seem to be invulnerable.

Assistant Secretary Roosevelt, of the Navy, has summed up these advantages in his statement that "with the fire risk eliminated, the rigid airship, or Zeppelin, will be one of the most powerful weapons known."

The only apparent disadvantage of helium is the fact that it is about twice as heavy as hydrogen, 100 cubic feet of helium weighing 17.8 ounces and the same volume of hydrogen only 9 ounces. Both gases, however, are so exceedingly light in comparison with air (which weighs 8 pounds per 100 cubic feet) that this is of little practical importance, the buoyancy, or lifting power, of helium being 93 per cent that of hydrogen. Moreover, this greater weight has its compensations, for hydrogen is so light that it passes through the walls of the gas bag and escapes at a far more rapid rate than helium.

THE SUN GAVE US THE CLUE TO HELIUM

Helium is one of nature's own products, being a true chemical element—a body that cannot be broken up or decomposed into other simpler substances—and is not to be confused with materials like mustard gas, which are manufactured compounds. Helium, moreover, is one of the most interesting of all the elements.

Prior to about 1860 the chemist could deal only with substances that he could actually hold in his hands and weigh on the chemical balance; but the invention of the spectroscope opened up a new field, for it permitted him to study at a distance the gases or vapors given off by all substances when heated.

The spectroscope depends on the familiar principle of the prism, which breaks up sunlight into the colors of the rainbow or spectrum; but it is arranged to take advantage of the fact that the light given out by a white-hot mass of iron, for example, produces certain characteristic lines rather than the continuous band of rainbow colors. Each element has its characteristic spectrum by which it may be identified, whether it happens to be on the laboratory table or in some distant star.

In 1868 an eclipse of the sun was visible in India, and for the first time the spectroscope was used to examine the colored atmosphere which envelops the sun.

Many of our familiar earthly elements, like sodium, iron, hydrogen, etc., were identified, but the British astronomer, Lockyer, observed a bright yellow line in the spectrum which did not correspond with that of any known substance. He concluded, therefore, that he had discovered a new element, and named it helium, after the Greek word for the sun, ἥλιος.

HOW HELIUM WAS FOUND ON EARTH

It was not until 1895, or twenty-seven years later, that helium was actually found on the earth, and the circumstances attending its discovery are interesting.

In 1888 Dr. Hillebrand, of the U. S. Geological Survey, found that the heavy, black mineral uraninite, when treated with acid, gave off an inactive gas, and having proved that this gas was in part nitrogen, he concluded, as no other such gases were then known, that it was all nitrogen. Four years later, however, Lord Rayleigh and Sir William Ramsay discovered a new element in the atmosphere—a heavy, inert gas which they named argon.

In 1895 Ramsay heard of Hillebrand's work on the inert gas given off by uraninite and at once suspected that this gas

Official photograph, U. S. Naval Air Service

RESCUING AN AVIATOR FROM ONE OF THE FLORIDA KEYS

To demonstrate the ease and accuracy with which its dirigibles can be navigated, the crew of one of the U. S. Navy's airships "marooned" one of their number on an island and sailed away. After a brief cruise, the dirigible was brought back and its rope ladder dropped overboard, within reach of the aviator who had been left behind. In the photograph the rescued man is seen climbing aloft as their airship resumes its journey.

might contain argon. Accordingly, he extracted some of the gas for himself; but he, too, was mistaken, for it proved to be not argon, but the element helium, which Lockyer had seen in the sun so long before.

After that, oddly enough, it was only a year or so before various other chemists detected helium in the atmosphere, in the gas given off by mineral springs, and in the volcanic fumes of Vesuvius. None of these gases, however, contain more than a fraction of one per cent of helium—the atmosphere itself contains only four ten-thousandths of one per cent—and although helium was thus found to be widely distributed, it was always regarded as one of the rare elements.

Although the discovery of helium in natural gas has proved to be a great boon to the United States, it was a rather sor-

Photograph courtesy Division of Military Aëronautics

MILITARY OBSERVERS DESCENDING IN PARACHUTES FROM THEIR BALLOON

The observation balloon, which has been successfully attacked by a Hun aviator, can be seen far above. A moment after the taking of this photograph, at Dravigny, France, the kite balloon burst into flames as the result of incendiary bullets fired into its hydrogen-filled bag (see illustration, next page). The two observers can be clearly distinguished swinging safely to earth, sustained by the graceful white parachutes.

Photograph courtesy Division of Military Aëronautics

INCENDIARY BULLETS, WHICH DESTROYED THIS OBSERVATION BALLOON, WILL HAVE NO TERRORS FOR THE AËRONAUTS OF THE NEXT WAR (FOR THE FIRST PHASE OF THIS INCIDENT OF THE WAR IN THE AIR, SEE THE PRECEDING PAGE)

At the time of the signing of the armistice, America was just entering upon quantity production of helium. The first shipment to France of 150,000 cubic feet of the new balloon gas had been made. Gas fields already located in the United States are capable of producing, if the necessity arises, 250,000,000 cubic feet of helium gas annually for the next three years, and there are excellent prospects that other fields will be found.

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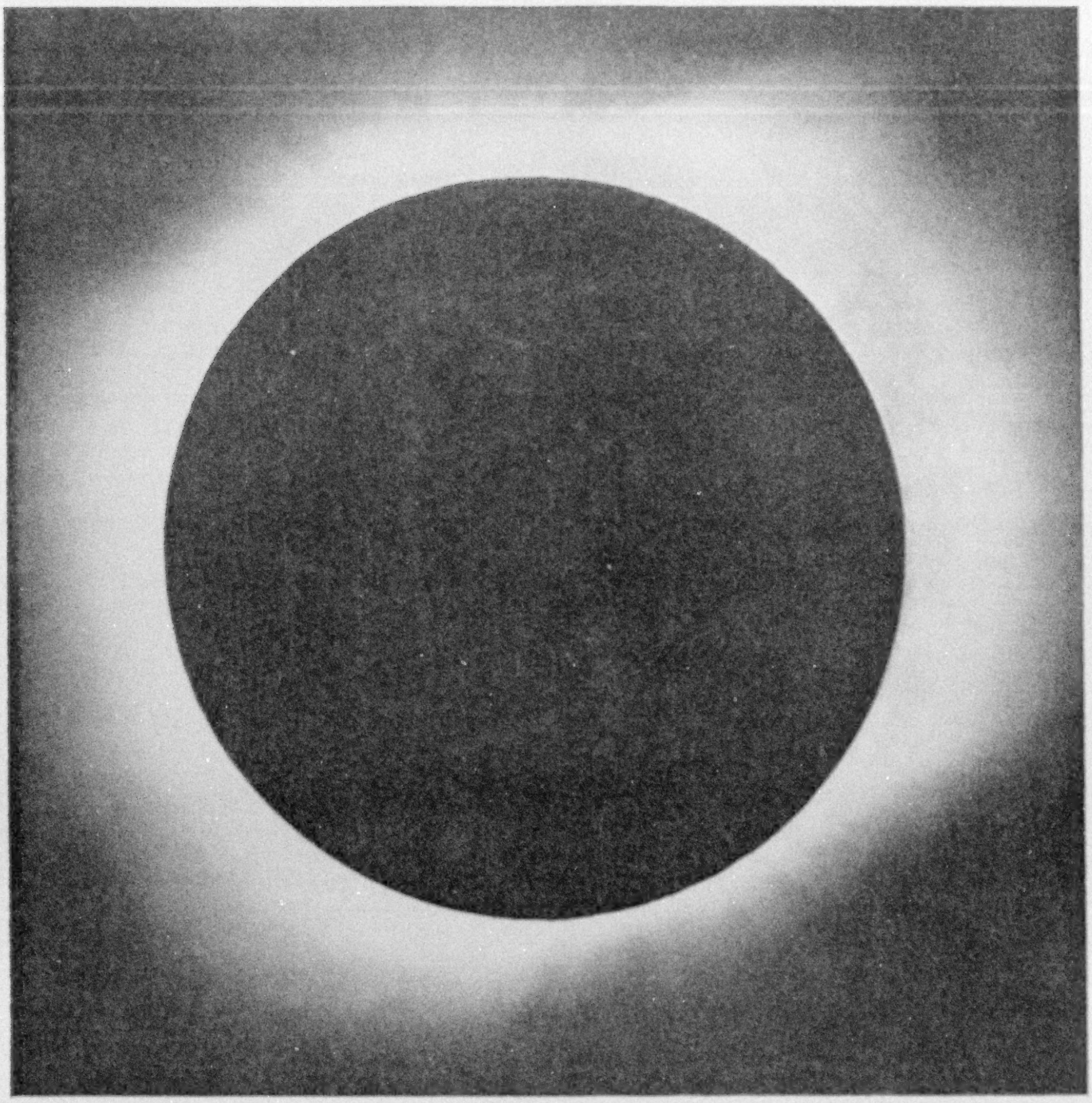

Photograph from U. S. Naval Observatory

CORONA OF THE SUN DURING A TOTAL ECLIPSE: SCIENCE DISCOVERED HELIUM IN THE ATMOSPHERE OF THE SUN LONG BEFORE IT WAS KNOWN TO EXIST ON OUR OWN PLANET

It was during a total eclipse of the sun, visible in India in 1868, that Lockyer, a British astronomer, saw in the spectroscope a bright yellow line which did not correspond to the line of any then known element. He called it helium, after the Greek word for sun. Twenty-seven years later an element was found on earth which gave the same bright yellow line in the spectrum. Thus, what the sun had revealed half a century ago as existing more than ninety million miles beyond our reach, began to be studied at first hand in 1895. Today that gas promises to make the ship of the skies a safe and practical reality.

rowful event for one of its good citizens. In 1903 a well was drilled at the little village of Dexter, in southern Kansas, and a great flow of natural gas was encountered. The nearest gas field at that time lay a considerable distance to the east, and the owner of the well, having visions of Dexter becoming a great manufacturing center, invited the countryside to assemble and celebrate the event.

On the day appointed, and in the presence of a goodly crowd, the well was opened and the gas allowed to roar forth; whereupon, in order to make the demonstration dramatically complete, a lighted torch was thrust into the gas—and the

torch promptly went out. Several more attempts were made, but the gas absolutely refused to burn. Gloom descended on the assemblage, and visions of cheap fuel and manufacturing wealth went glimmering.

A sample of this gas was sent to the University of Kansas for analysis and the secret of its fireproof qualities was at once revealed, for it was found to contain only about 14 per cent of the combustible hydrocarbons which ordinarily make up natural gas, and to consist for the most part of nitrogen.

MILLIONS OF FEET OF HELIUM GAS WASTED

As nothing like this had been discovered before, Prof. H. P. Cady, of the University of Kansas, examined this inert portion of the gas further and finally discovered helium in it. He at once collected samples of gas from a number of other localities in Kansas and elsewhere and found a little helium in all but one; but the Dexter sample, which contained 1.84 per cent, was the richest of all.

I may add that all our recent work has confirmed this relation; gases high in nitrogen, and therefore poor in heating value, are likely to carry considerable helium; and, on the other hand, no high-grade hydrocarbon gas has been found to carry enough helium to be of value.

The announcement of Professor Cady's discovery created some interest in scientific circles, but as no one knew of any practical use for helium it had no commercial value.

After the Dexter episode similar gas was found at many points in southern Kansas, but because of its poor burning qualities it was contemptuously called the "wind gas." It was generally encountered at shallow depths by wells aiming for the deeper-lying oil sands, and, being usually under enough pressure to interfere with the drilling, was regarded as a great nuisance.

It was customary to allow this wind gas to blow wild into the air until exhausted; and how many million cubic feet of valuable helium have been wasted in this way no one can ever estimate.

No one seems to know just who conceived the idea of using helium in balloons, though apparently it originated in England. Like all great ideas, it is beautifully simple; yet, so long had helium been regarded simply as a chemical curiosity, that apparently the stimulus of war was necessary for the correlation of two well-known facts: first, that helium would be ideal for balloons; and, second, that plentiful supplies were available.

At any rate, within a few months after the war began a search for helium in the gases of English coal mines was started, but it met with no success. It was later extended to Canada, but the quantities of helium found in the natural gas there were too small to be of value.

Italy, when she entered the war, also took a hand in the search, and unsuccessful attempts were made to extract helium from the volcanic gases that issue from the fumaroles around Naples.

ORGANIZING THE CAMPAIGN FOR HELIUM PRODUCTION

When the United States joined the Allies, the military value of helium was at once brought to the attention of the Army and Navy authorities, and a vigorous campaign was begun for the production of helium in quantities sufficient not only for this country, but for England and France as well.

The two main problems were obvious: first, to develop methods of extracting helium from the natural gas; and, second, to determine the geologic occurrence of the gas, and so to locate adequate supplies.

The task of developing methods of extracting the gas was accomplished by the Bureau of Mines, acting in coöperation with the Army and Navy. Late in 1917 two small experimental plants using different methods were erected in Fort Worth, Texas, to treat the gas of the Petrolia field; and some months later a third plant, using still a different method, was erected in the field itself.

As the apparatus used in all these processes requires rather delicate adjustment and manipulation, some time was naturally consumed in determining the most efficient working conditions; but just prior to the armistice the first shipment of 150,000 cubic feet of helium, com-

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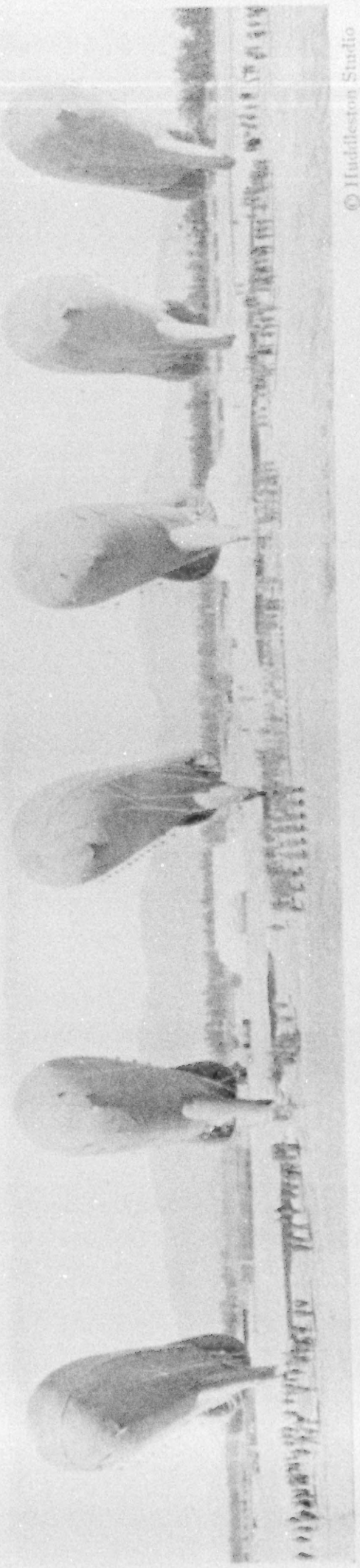

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A SEXTET OF SKY-SCRAPERS READY FOR A FLIGHT AT U. S. ARMY BALLOON SCHOOL, ARCADIA, CALIFORNIA

The standard observation balloon of the United States Army has a capacity of 35,000 cubic feet of gas. At the present price of hydrogen, the cost of inflation ranges between $300 and $375. Helium gas can now be manufactured at less than 10 cents a cubic foot, but as its lifting power is somewhat less than hydrogen, inflation of a similar type of balloon with this non-inflammable substance would cost in the neighborhood of $4,000. This sum will be materially reduced if a third method of manufacture, now being tested, proves practical. The average Navy dirigible airship has a gas capacity of 100,000 cubic feet (costing for inflation with hydrogen from $850 to $1,100). The British superdreadnought of the skies, the R-33, is said to have a capacity of 2,750,000 cubic feet, which represents $25,000 to $30,000 worth of hydrogen gas.

pressed and stored in steel tanks, had been started to Europe. This was enough to fill four of the ordinary kite balloons, though the large dirigibles require one to two million or more cubic feet of gas.

A GREAT ACCOMPLISHMENT

Although quantity production of helium was achieved just too late to be of value in the actual hostilities, it was in itself a great accomplishment, for the world's total output of helium up to 1915 was probably less than 100 cubic feet, the market value of which was about $1,700 a cubic foot. Our helium, on the other hand, can be produced by the first two methods at less than 10 cents a cubic foot, and if the third process fulfills the expectations of Bureau of Mines experts, this figure will be still further reduced.

All of our helium so far, however, has been the product of the first two experimental plants; the third plant has not yet been put on a practical working basis, though the fact that it holds promise of producing helium much more cheaply than the other two justifies further experimentation with it.

The details of the process of extracting helium are highly technical, but the general scheme is easily understood. All of the main constituents of natural gas, including the nitrogen, become liquefied when cooled to about —328° Fahrenheit; but the helium remains a gas at this exceedingly low temperature and is thus easily separated.

The principle by which these low temperatures are attained is one known to every motorist who is unfortunate enough to have to pump up his own tires. When air is compressed in a tire it becomes hot; if the tire is allowed to cool to ordinary temperature and the valve is then opened and the air allowed to escape, it becomes cool.

Similarly, the natural gas is put under a very high pressure and then refrigerated, and when allowed to expand it becomes so cold that all of its constituents except helium be-

come liquid. The liquid, after being separated from the helium gas, is allowed to warm up until it returns to its normal gaseous condition, when it is put back into the mains and used as ordinary natural gas.

This process does not in the least injure the quality of the natural gas for heating purposes—in fact, it improves it, for the helium, the only substance removed, is incombustible.

THE SEARCH FOR HELIUM-BEARING GASES

While the experimental work on extracting helium was under way, members of the Geological Survey, of whom I was one, were engaged in a search for further supplies of the helium-bearing gas, for it was very evident that the Petrolia, Texas, field, in which operations were started, would supply only a fraction of the quantity desired by the United States alone. Furthermore, a gas field is an ephemeral thing, some fields lasting ten years and others only a year or so; so that it was necessary not only to keep the supply ahead of the demand, but to estimate as closely as possible how long each field would last, and in this way avoid the mistake of installing expensive machinery in a practically exhausted field.

This work was begun in June, 1918, and in September the Geological Survey was able to advise the military authorities that sufficient supplies of the gas had been located to furnish over five million cubic feet of helium per week, or enough to meet the demands of the United States and of Great Britain and France as well.

The search for helium was simplified by the fact that all the helium-rich gases are apparently poor in heating value, and information as to the heating quality of a gas is usually not difficult to obtain.

The richest gas is the "wind gas" of southern Kansas and northern Oklahoma, which for so many years had consistently been allowed to go to waste. A sample of this gas which I collected in the Augusta field, Kans., contained over 2 per cent of helium and is the richest variety known.

WHERE AND HOW THE GAS OCCURS

We soon found, moreover, that in the Kansas, Oklahoma, and Texas fields the helium gas occurs only in a certain group of geologic formations, and that in the strata above and below this group the helium content is very low. Another characteristic of the rich gas is its common occurrence at shallow depths—the best gas usually occurs above 600 or 800 feet, and gas in sands deeper than 1,600 feet is very poor in helium.

These three principles, once established, narrowed down the promising areas considerably and permitted intensive studies of the richest supplies. In some of the best fields practically every gas well was sampled, the samples being taken in small steel tubes, especially designed for the purpose, and sent immediately to the Bureau of Mines laboratory for analysis.

Possible sources outside of the Kansas-Oklahoma-Texas area were not neglected, however; many samples were collected in Ohio, Wyoming, Louisiana, Montana, California, and elsewhere, but only in Ohio were valuable supplies discovered.

OUR LARGEST HELIUM FIELD

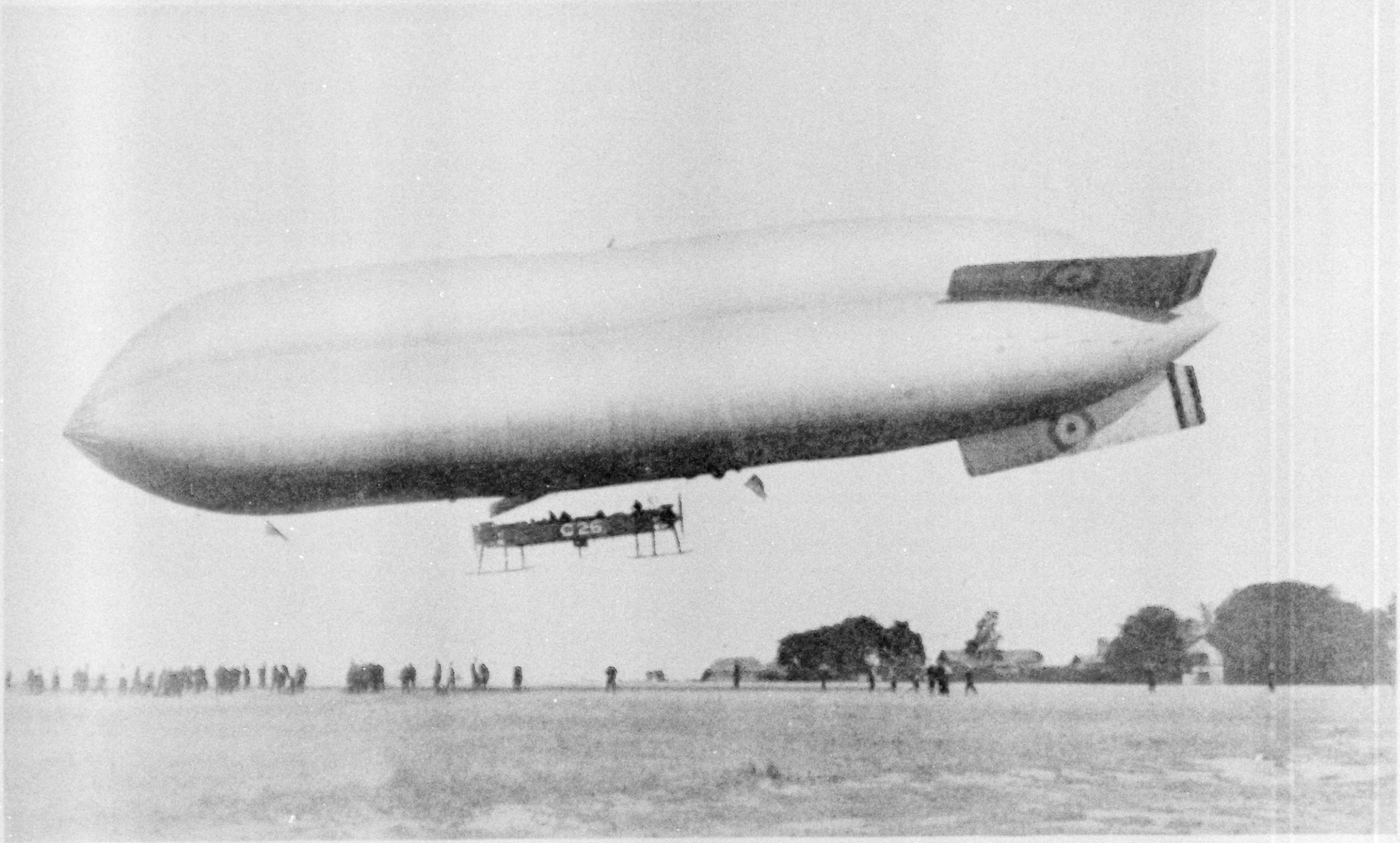
The largest of the helium gas fields is Petrolia, which is located on the flat prairies of northern Texas, about 100 miles north of Fort Worth. The gas here is found in sands from 1,400 to 1,600 feet deep and carries practically 1 per cent of helium, which is regarded as a good working proposition.

It is the Petrolia gas that is now being treated by the small experimental plants, and the Government has taken a ten-year lease on the helium output of the field and is now erecting plants capable of turning out at least 50,000 cubic feet a day.

At present there are about fifty gas wells in Petrolia, some of which originally produced as much as 30 or 40 million cubic feet of raw gas a day. When the field was first opened, about 1910, the gas issued under a pressure of 700 pounds per square inch, but the field has now seen its best days and the pressure has declined to less than 100 pounds.

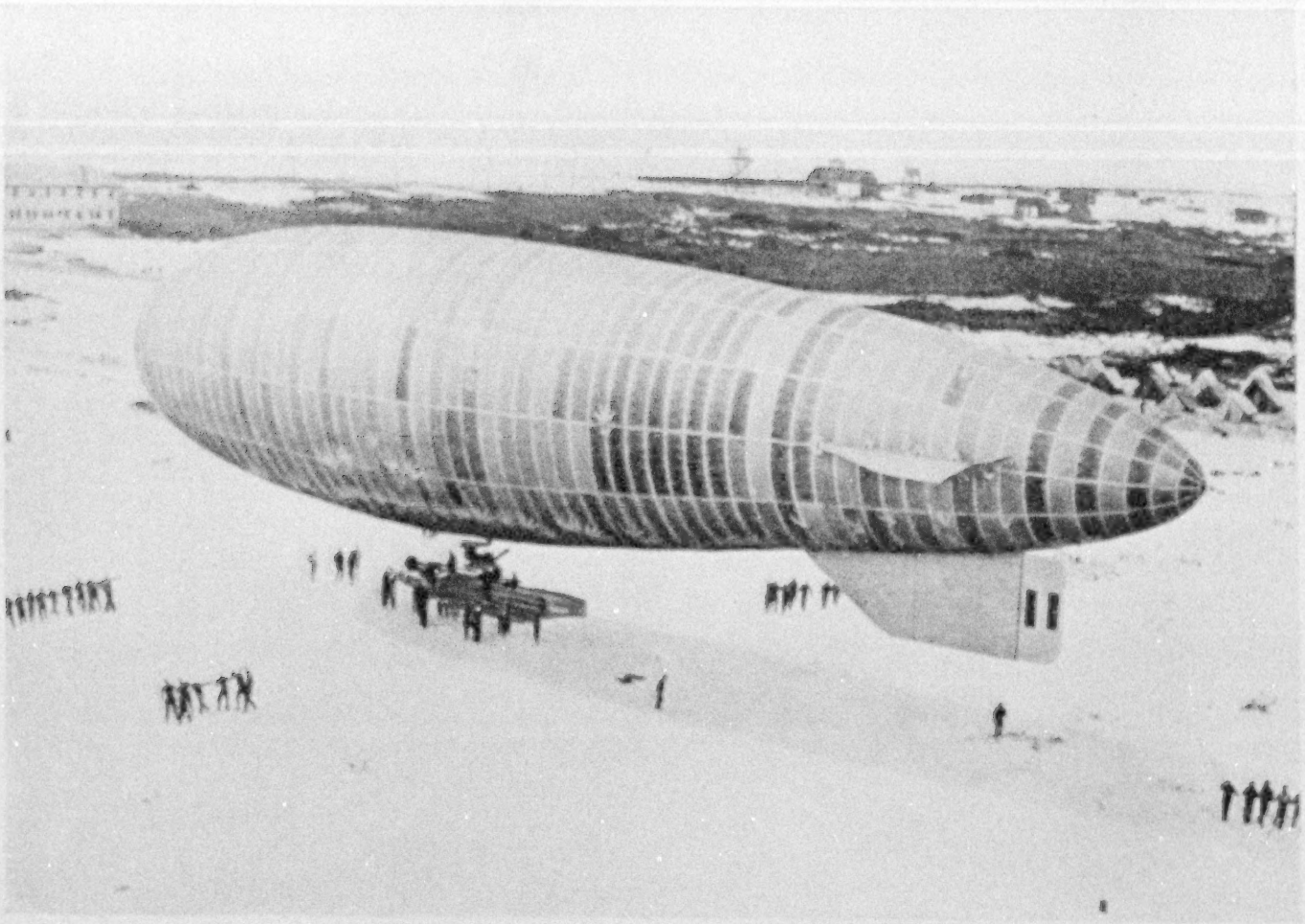
Had the demand for helium come three years earlier, Petrolia alone could probably have furnished enough to satisfy the military program of the United States, but the production of the field has now fallen to a point where the helium content totals less than a million cubic feet

XUM



A COASTAL AIRSHIP IN THE HANDS OF A LANDING PARTY, SHOWING A GUN MOUNTED ON TOP OF THE ENVELOPE

Before the use of helium as the lifting gas of dirigibles, it was a dangerous practice to mount a gun on top of the bag for defense against airplane attacks. A single spark from the muzzle, touching and igniting the envelope and exploding its contents of hydrogen gas, would have been sufficient to reduce this mammoth flyer to a tangled heap of useless rubbish.



Official photograph, U. S. Naval Air Service

U. S. NAVY DIRIGIBLE C-1 READY TO START ON A 1,500-MILE FLIGHT FROM ROCKAWAY BEACH, LONG ISLAND, TO KEY WEST, FLORIDA

a week. When the first gas well was drilled at Petrolia, I estimate that the field contained slightly over a billion cubic feet of helium, which is a pretty respectable accumulation for a "rare element."

About 100 miles south of Petrolia lies the great oil and gas region in which the famous Ranger field is located. The gas in this district occurs in formations slightly older than the helium-rich strata farther north, and for this reason we had little hope that it would prove helium-bearing; but, needless to say, this inference was checked—and fully confirmed—by actual tests. I believe, however, if gas is discovered, as it probably will be, in the area southwest of Petrolia that it will prove to be of value for its helium content.

THE HELIUM-BEARING AREA OF KANSAS

The helium-bearing area of Kansas is far larger than any yet discovered in Texas and contains a number of fields which in the aggregate yields much more gas than Petrolia. Some of the Kansas gas, moreover, contains twice as much helium as the Petrolia gas, though on the average the Kansas variety is only slightly richer.

The Eldorado field—the richest oil field ever developed in Kansas, and one of the most prolific fields of high-grade oil in the world—yields gas which averages about 1¼ per cent of helium. This gas is found at a depth of 900 to 1,200 feet, or considerably above the rich oil sands.

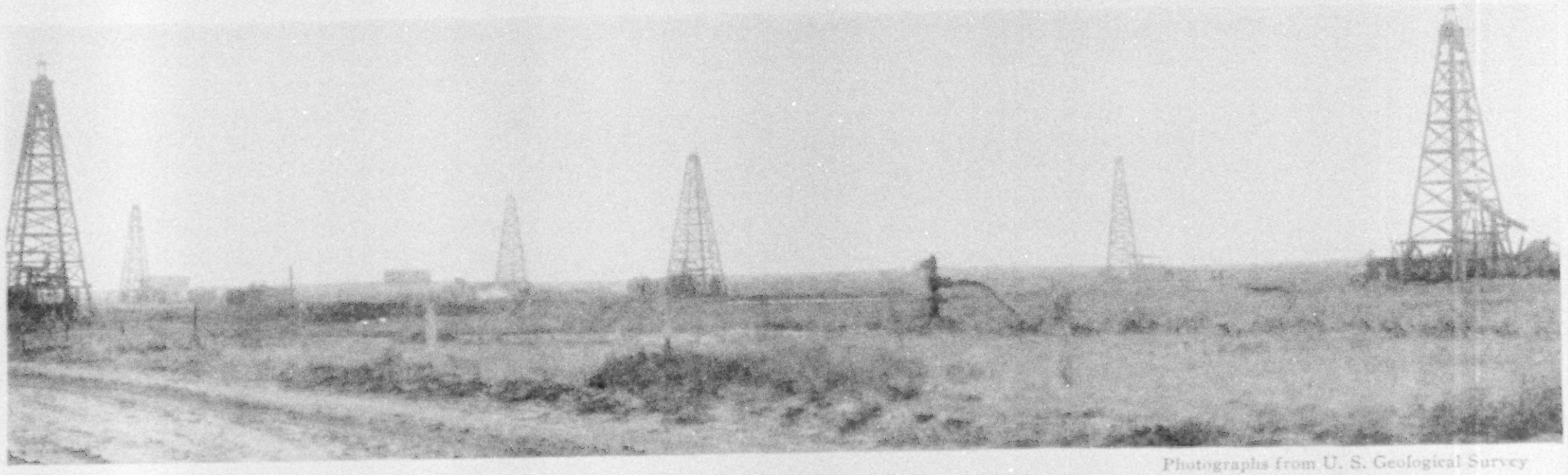
A few miles to the south is the Augusta field, which yields two distinct varieties of gas—a "wind gas," practically incombustible, which occurs at 500 feet and carries about 2 per cent of helium, and a deeper gas which carries about half a per cent.

The gas resources of both these fields have fallen off considerably in the last few years, though the total helium content of their combined product is still nearly a million cubic feet per week.

The old Dexter field, in which the helium-bearing gas was first discovered, is now exhausted, though the early diffi-

VIEWS IN THE ELDORADO FIELD, KANSAS: ONE OF NATURE'S HELIUM STOREHOUSES

This is the richest oil field ever developed in Kansas, and it also produces gas slightly richer in helium than the gas found at Petrolia and now being used by the government.



Photographs from U. S. Geological Survey

A VIEW OF THE WELLS AT PETROLIA, TEXAS, THE LARGEST OF OUR HELIUM GAS FIELDS

Beneath these monotonous prairies is the greatest accumulation of helium known anywhere in the world.

culties in the way of burning the gas were overcome, and for years it was produced in large volumes and used as fuel.

HELIUM GAS THE BANE OF HOUSEWIVES

To light a gas stove in Dexter, however, was always a difficult feat, and it became a matter of pride on the part of every good housewife to develop the dexterity necessary to this operation. The stove was first filled with crumpled newspaper, which was set afire; then the gas was turned on, its flow being skillfully manipulated, until by the time the paper had burned out the gas had become hot enough to take fire.

About 7,000 cubic feet of this gas was necessary to produce the heat of 1,000 cubic feet of the ordinary variety, however, and we who think of gas at a dollar a thousand will pray that no such variety is discovered in our own neighborhoods.

Although the old Dexter field is exhausted, there is favorable territory in the vicinity in which further supplies may be discovered, and about 20 miles eastward lies the Sedan field, which produces gas carrying over 1 per cent of helium. At present the actual production of this field is small, but this is chiefly because there is little market for the gas on account of its poor heating qualities. With proper development, this area may become the most prolific of all.

The Geological Survey is preparing to issue a detailed report on the helium-bearing gas fields and a further description of them here would be tedious.

The only promising source of supply outside of the mid-continent area is located in Vinton County, Ohio, about 80 miles south of Columbus. This gas occurs in strata considerably older than those in the Kansas and Texas areas and contains only a third of a per cent of helium; but, on the other hand, there is an enormous quantity available and it is under high pressure. Whether it could be worked at a profit by the present methods is doubtful; but if the new extraction process materializes, it should make this great supply available as a commercial source of helium.

The gases of Louisiana, Wyoming, Montana, and California occur in strata that are much younger than those of the mid-continent area, and I think there is little prospect of locating a helium supply in those States.

The fields already described, however, are capable of producing, if necessary, a quarter of a billion cubic feet of helium a year for the next three years, and there is an excellent chance that further supplies will be discovered in northern Texas, northern Oklahoma, and southern Kansas.

NO OTHER COUNTRIES HAVE DISCOVERED RICH HELIUM RESOURCES

So far as we know, no other countries have any commercial supplies of helium, though it would, of course, be foolish to state that none will ever be discovered. Great Britain, however, was thoroughly searched for helium gases during the war without success.

In France there are some mineral springs which emit gas rich in helium, but the total volume per year is insignificant. Far larger volumes of helium are contained in the "fire-damp" of French and Belgium coal mines, but the proportions are so small that there is little hope of extracting the helium commercially.

The return of Alsace puts France in possession of an oil field in which some gas is produced, but the normal variety contains only a trace of helium. A deep test-hole near Pechelbronn, however, found in the older formations a little gas which carries 0.4 per cent.

In Italy some gas is produced on the northern flank of the Apennines, but two analyses of this gas showed only very minute quantities of helium.

Germany produces a little gas near Hamburg, but the helium content is only 0.014 per cent, and the Austrian gas produced near Wels contains even less.

The only gas field in Europe which compares in size with our American fields is located in Transylvania, and several analyses of this gas show less than 0.002 per cent helium. The Roumanian and Galician oil fields on the Carpathian front yield very little gas, and the Baku fields of Russia are also primarily oil producers.

Some gas has been found in Russia, near Samara, which carries considerable nitrogen, and may possibly be helium-

XUM

bearing, but there is not much likelihood of its becoming a commercial source.

HOW DOES HELIUM GAS HAPPEN?

It is a pity that the story of helium cannot be closed with a theory explaining its origin and occurrence, but no satisfactory theory has yet been suggested. Geologists believe that natural gas itself is a product of the decay of the vegetable and animal remains buried in the rocks; but, as helium is found also in mineral spring and volcanic gases, this seems to have no special significance.

Some believe that the helium has arisen from great depths in the earth and has simply mingled with whatever gases it happened to meet, but the largest volumes of helium are found in regions remote from any known fissures through which the gas could ascend, and, furthermore, it is difficult to understand why the helium should rise almost to the surface and there remain.

There is, of course, an enormous volume, in the aggregate, of helium in the atmosphere (where it is about as valuable as the gold in sea-water), but there is no good reason to suppose that the helium in natural gas has been absorbed from that source.

THE RADIUM THEORY

There is a third possibility, more attractive and fascinating, perhaps, than the other two, namely, that helium is derived from radium.

Every one now knows the wonderful qualities of radium—its property of giving off heat enough to burn the flesh if a tiny grain of radium is placed on it; its faculty of being luminous in the dark, and so on. Radium is ordinarily considered one of the chemical elements, but its discovery upset all the old notions about the permanency and indivisibility of the elements; for the extraordinary properties of radium are due to the fact that it is continually breaking down, at a slow, but constant, rate, into other substances.

One of these substances is a gas called radium emanation, and this in turn breaks down into another body, called Radium A, and so on through a whole chain of similar substances until it finally becomes the unromantic element which we call lead.

This is only half the story, however, for when radium breaks down into the emanation, the other substance formed is helium, and as each one of the other radio-elements disintegrates it also generates helium. It is curious to reflect that these changes are constantly proceeding, even in the minute quantities of radium in the luminous dials of our watches, and that under our watch crystals infinitesimal volumes of helium are being generated hourly.

RADIUM WIDELY DISSEMINATED

As the world's total output of refined and purified radium amounts to only four or five ounces, valued at over three million dollars an ounce, it may well be asked how so rare and precious a substance can be called upon to explain the vast accumulations of helium in natural gas.

As a matter of fact, however, although deposits of radium ore rich enough to mine are few, the element itself is widely disseminated through ordinary rocks. The quantities are so exceedingly minute that were it not for the great activity of radium, it could never be detected; but by the use of an instrument known as the electroscope, incomparably more delicate than the finest assayers' balance, the presence of only a few trillionths of 1 per cent of radium in a rock may easily be determined.

The amount of radium in a pound of rock or in a ton is utterly insignificant, but the total quantity in a cubic mile is enough to generate, according to a calculation of mine, about half a cubic foot of helium a year. This, too, sounds small; but multiply the cubic mile by a few thousand and the year by a few million and the total volume of helium begins to assume formidable proportions.

There is really little doubt but what there is enough radium scattered through the earth's crust to account for all the helium we know of, though whether the helium actually *did* originate in this way is a matter concerning which scientists disagree.

INDEX FOR VOLUME XXXIV—JULY-DECEMBER, 1918—WILL BE MAILED TO MEMBERS UPON REQUEST

Look inside the lid!

If it hasn't this trademark, it isn't a Victrola

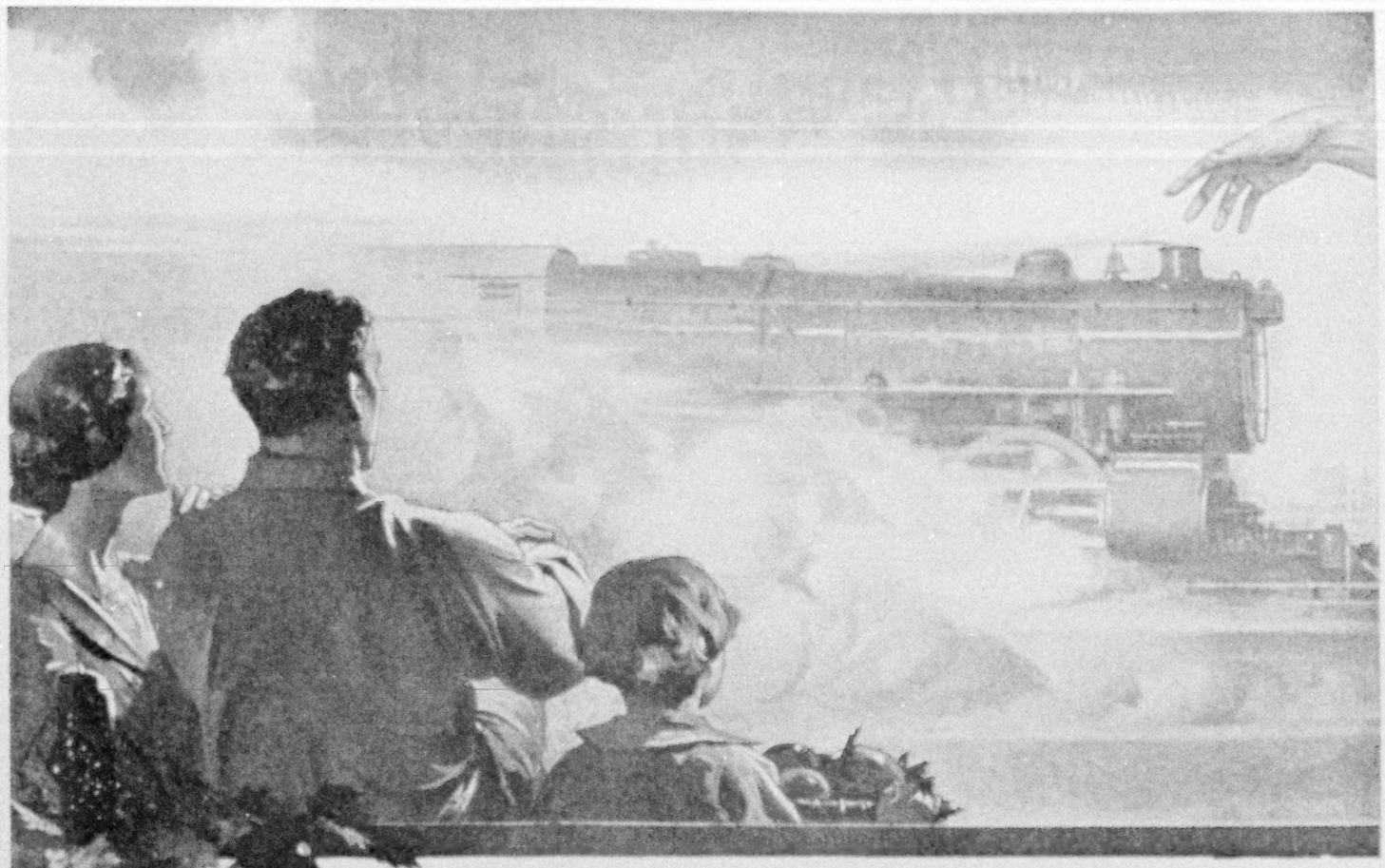
You can readily identify the Victrola by the famous Victor trademark "His Master's Voice." It is not a Victrola without the Victor dog. This trademark is on every Victrola. It guarantees the quality and protects you from inferior substitutes.

The word "Victrola" is also a registered trademark of the Victor Talking Machine Company. It is derived from the word "Victor" and designates the products of the Victor Company only. As applied to sound-reproducing instruments, "Victrola" refers only to the instruments made by the Victor Company—the choice of the world's greatest artists.

Look inside the lid—insist upon seeing the famous Victor trademarks. On the portable styles which have no lid, the Victor trademark appears on the side of the cabinet.

Victor Talking Machine Co., Camden, N. J., U. S. A.

XUM



Forward—and at a new pace!

Carrier of civilization and prosperity!

Follow the network of his level steel rails and you follow the swift routes of a nation's progress.

Thanks to far the greatest railroad system in the world, our national prosperity far exceeds that of any other country in the family of nations.

Without unconquerable American belief, backed by money invested in American railroad bonds, your country would be as railroad-less as undeveloped China.

Today the holdings of your American railroad bonds are spread and keep spreading among countless thousands of American men and women.

They know that the building of railroads is made possible only by money which they have loaned through the medium of railroad bonds.

Yet railroad bonds are but one group in the complete range of investment securities offered to and bought by the public. The American investor, fast growing in numbers, needs help, accurate information, dependable advice.

For his protection, our national organization constructively studies the soundness of investment securities—gets the facts, analyzes their meaning.

This service is placed at the command of every one who saves money and wishes to invest it soundly.

The National City Company

National City Bank Building, New York

THE NATIONAL CITY COMPANY
NATIONAL CITY BANK BUILDING
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You will find a National City Company Correspondent Office in 47 of the leading cities of the country.

Each of these offices is equipped to render unusual service to investors generally, and to bond buyers in particular.

BONDS
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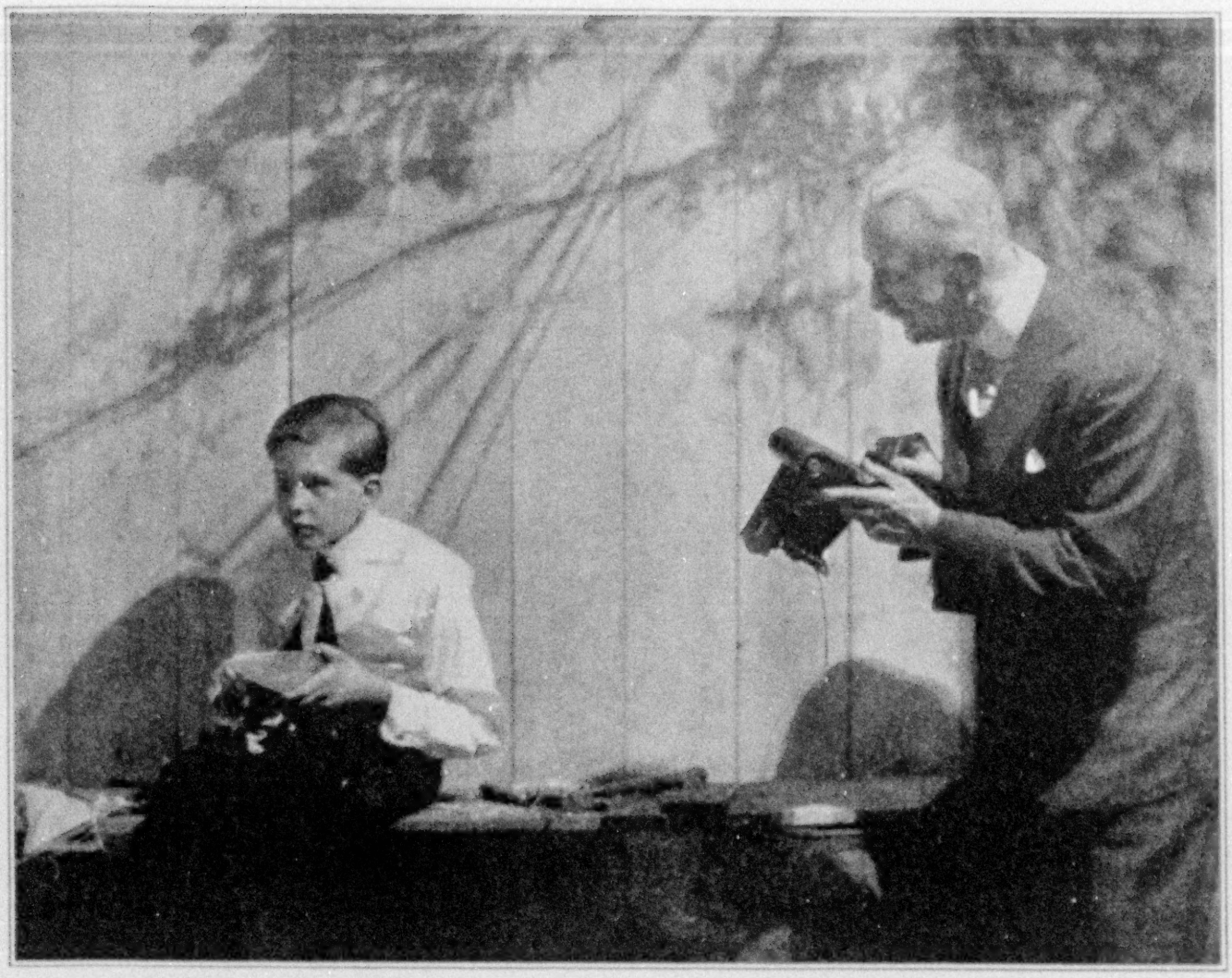
ACCEPTANCES

Make the Kodak Record Automatic.



For the Days to Come.

Building his boat of pine and dreaming, as he works, of the days when he will sail a real ship on a real ocean—a regular boy, that.

And Dad, with his Kodak, has caught the boyish story. Now he is writing the autographic record—the date and title on the film; the record that will give double value to the picture when time has played sad tricks with memory.

Make the family chronicle complete. Let every picture of the children bear at least a date. It's all very simple, as simple as taking the picture itself—with an

Autographic Kodak

EASTMAN KODAK CO., ROCHESTER, N. Y., *The Kodak City*

"Mention The Geographic—It identifies you"

Our Stockholders

There are over 135,000 stockholders who own the American Telephone and Telegraph Company. This great body of people, larger than the entire population of such cities as Albany, Dayton or Tacoma, share the earnings produced by the Bell System.

More than 45,000 of these partners are workers in the telephone organization. They are linemen, switch board operators, clerks, mechanics, electricians.

The vast property of the Bell System represents the savings of these thousands of people, in many cases *all* their savings.

In the truest sense of the word this big public service corporation belongs to the people. The people own it and the people receive the profits. More than 93% of its stock is owned by persons holding, each, less than one-ninth of one per cent.

The Bell System is a real industrial democracy. On its economic operation depends the future independence of many citizens of small means, as well as the profitable employment of thousands of other men and women.

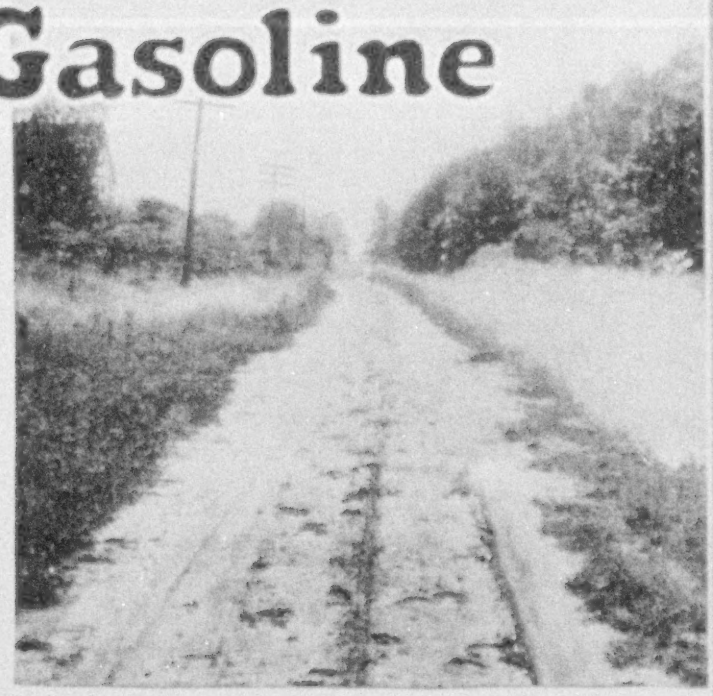
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
AND ASSOCIATED COMPANIES

One Policy *One System* *Universal Service*

"Mention The Geographic—It identifies you"

Concrete Roads and Gasoline

11.78 miles per gallon of gasoline on this concrete road. This is over double the mileage obtained on the earth road opposite.



5.78 miles per gallon of gasoline on this earth road—less than half the mileage obtained on the concrete road opposite.

Why Spend $2—$1 Will Do

Tests made last September at Cleveland, O., with five 2-ton White Trucks carrying full load, showed that on an earth road in fair condition, gasoline consumption was twice that on a concrete road.

The diagrams to the left and right illustrate the relative quantities of gasoline and its cost, used by one truck in making a 100-mile run under the same condition of load over the two roads pictured above. Think what 5,000,000 motor vehicles would save in gasoline alone if they always traveled on concrete.

Since one gallon of gasoline will carry you twice as far on a concrete road as it will on an earth road, why waste the other gallon?

You pay the price of good roads whether you get them or not, and if you pay for **concrete roads** they **pay you back.**

Let's Stop This Waste!

Illinois, Pennsylvania and Michigan have voted big, road bond issues to do away with the mud tax. Many other states and counties are going to do the same thing.

When You Think of Roads—Think of Concrete; When You Ride—Ride on Concrete

Write our nearest District Office for free copy of *"Concrete Pavements Pay for Themselves"* and *"Facts About Concrete Roads."*

PORTLAND CEMENT ASSOCIATION

OFFICES AT

ATLANTA	DENVER	HELENA	MILWAUKEE	PARKERSBURG	SEATTLE
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DALLAS	DETROIT	KANSAS CITY	NEW YORK	SALT LAKE CITY	WASHINGTON

PAVE THE ROAD—DOUBLE THE LOAD

The pattern of good candy

The quaint wooden frame in which the old-time sampler was usually embroidered held the canvas of the needleworker's art. Some samplers, started early in life and added to from year to year, expressed a whole life-time of artistic effort.

Whitman's Sampler—"started in 1842"—sums up the three quarters of a century we have devoted to the art of making candy and making it *good*.

Each of the sweets in the Sampler tells, in its own original and delightful way, why Whitman's candies are famous throughout a whole continent. Selections from ten of our most favored packages are contained in the Sampler.

Sold all over the United States by Whitman agents—usually the better drug stores. Every package guaranteed by the agent and by us.

STEPHEN F. WHITMAN & SON, Inc., Philadelphia, U. S. A.
Makers of Whitman's Instantaneous Chocolate, Cocoa and Marshmallow Whip

DODGE BROTHERS

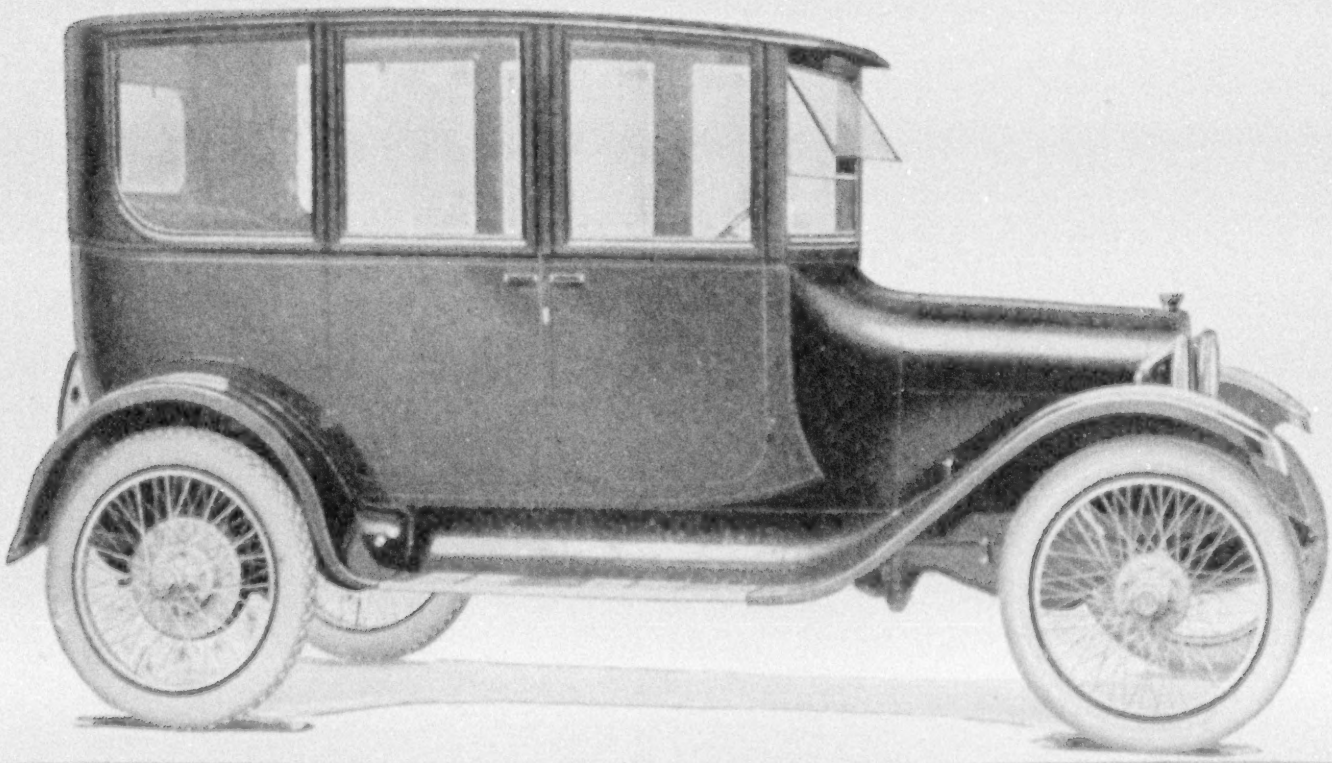
4 DOOR SEDAN

Comfort and convenience in entering or leaving, or changing places, is greatly increased by building the Sedan with four doors

Passengers in the front and rear seats are cooler in warm weather because the divided front seats permit the free circulation of air at the floor.

The gasoline consumption is unusually low
The tire mileage is unusually high

DODGE BROTHERS, DETROIT



Watch Teeth Whiten

As the Film Disappears

All Statements Approved by High Dental Authorities

You Must Awake

People must awake, as dentists have done, to this all-important fact.

Old methods of teeth cleaning are sadly inadequate. Teeth still discolor, still decay. Tartar forms and pyorrhea starts. Statistics show that tooth troubles have constantly increased.

Dental science finds the reason in a slimy film. You can feel it with your tongue. It clings to teeth, gets into crevices, hardens and stays. The ordinary dentifrice cannot dissolve it.

That film is what discolors — not the teeth. It is the basis of tartar. It holds food substance which ferments and forms acid. It holds the acid in contact with the teeth to cause decay.

Millions of germs breed in it. They, with tartar, are the chief cause of pyorrhea. So most tooth troubles are now traced to that film.

Since this became known, science has sought ways to combat film. And now the way is found. Able authorities have proved it by many clinical tests. Leading dentists everywhere are urging its adoption.

The way has been embodied in a dentifrice called Pepsodent. And to hasten better tooth protection we are offering every one a 10-day tube to try.

Prove It Yourself

No argument is necessary if you will use this test tube and let Pepsodent prove itself.

Pepsodent is based on pepsin, the digestant of albumin. The film is albuminous matter. The object of Pepsodent is to dissolve it, then to constantly combat it.

But pepsin must be activated, and the usual method is an acid, harmful to the teeth. So pepsin long seemed impossible. But science now has found a harmless activating method. Five governments have already granted patents. That discovery means that we have conquered the teeth's chief enemy — the film.

Send this coupon for a 10-Day Tube. Use it like any tooth paste. Note how clean the teeth feel after using. Mark the absence of the slimy film. See how teeth whiten as the fixed film disappears.

Watch it ten days and you will know that really clean teeth are possible. That is something you should know at once.

Cut out the coupon now.

Pepsodent
REG. U.S. PAT. OFF.

The New-Day Dentifrice

A Scientific Product—
Sold by Druggists Everywhere

10-Day Tube Free

THE PEPSODENT CO.
Dept. 491, 1104 S. Wabash Ave.,
Chicago, Ill.

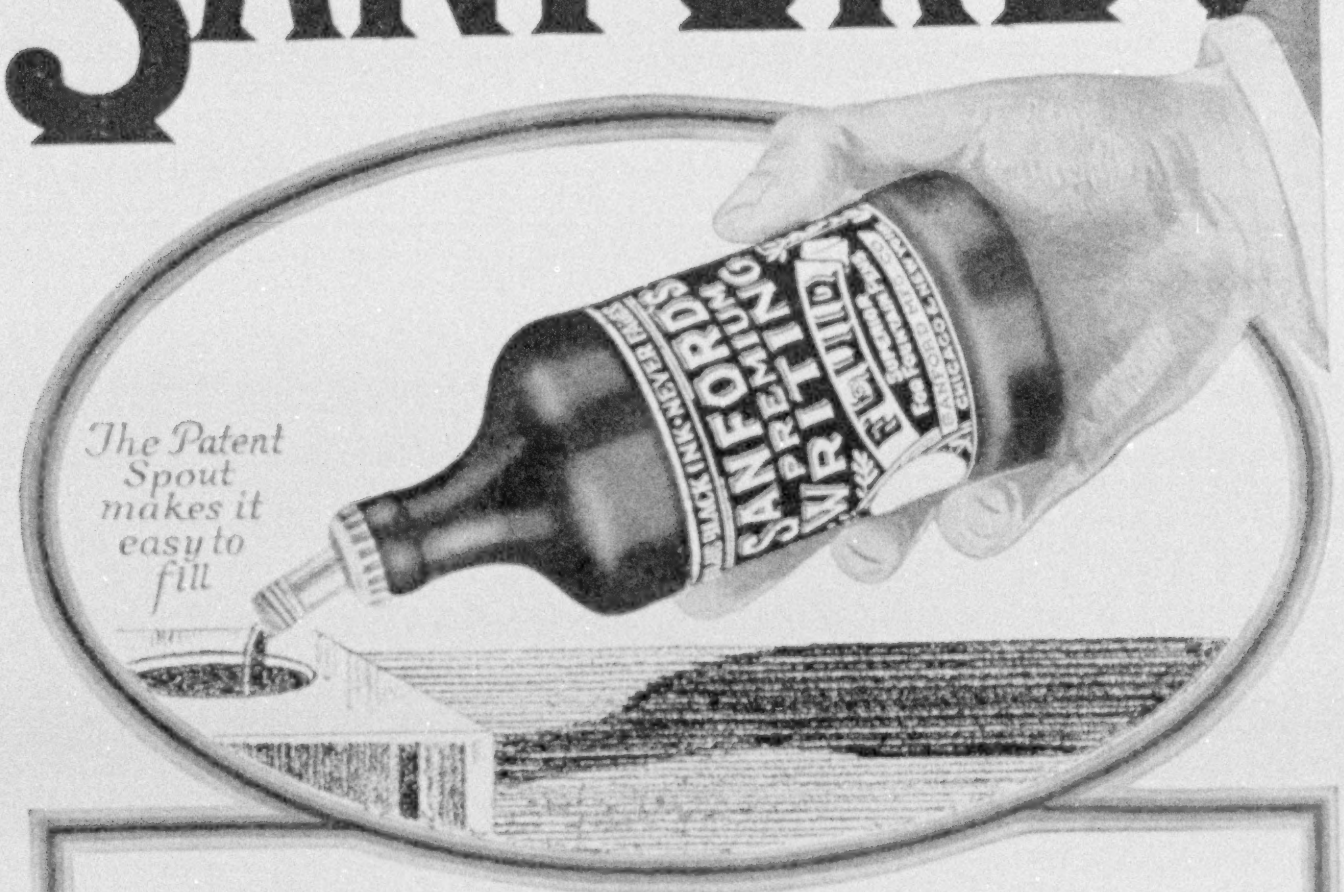
Mail 10-Day Tube of Pepsodent to

Name .....

Address .....

(165)

SANFORD'S



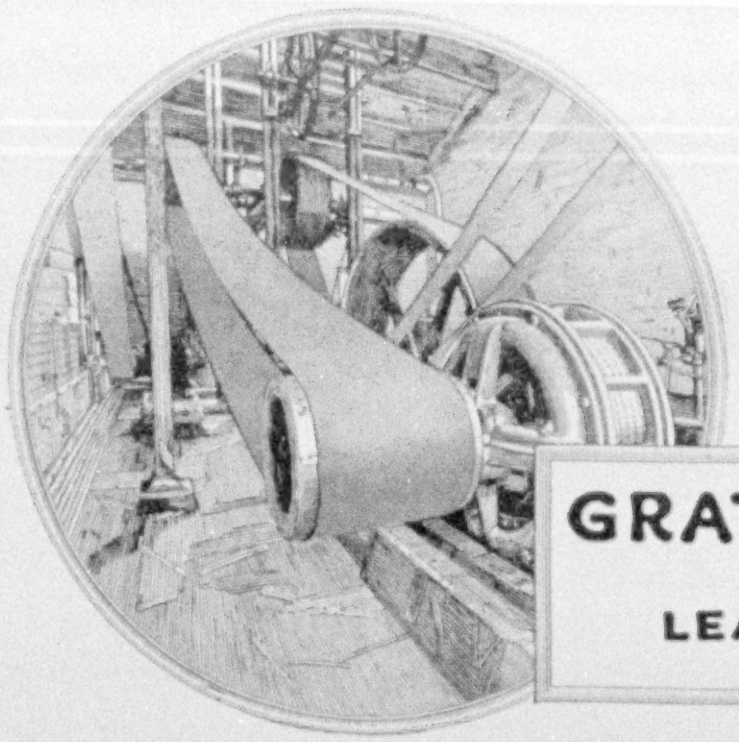
PREMIUM WRITING FLUID

Writes a Bright Blue

Changes to an everlasting black

NEVER FADES

For sale by all stationers



GRATON & KNIGHT

Standardized Series

LEATHER BELTING

Tanned by us for belting use

The Ledger gives the answer

HERE is pictured a 75-foot Graton & Knight Heart Brand Belt in the plant of the Model Mill Company, Johnston City, Tenn. It is 24 inches wide, double-thick. It transmits 241 horsepower. It has been in continuous hard service for five years. Its cost per week has been $1.35, or five mills per horsepower per week.

This is the story, told by the ledger, of a Graton & Knight Standardized Series Belt. It is a story of economy, full delivery of power, of long life, and the right material in the right place.

Leather is the right material for belting. It is firm. It is strong. It has permanent power of expansion and contraction. It is tough, but it yields in the *right* degree, at the right time. It is easily and repeatedly spliced or repaired. It stands mauling by shifters. Side-slapping won't fray it. After long use it can be cut into narrower belts and goes on with its good work.

Leather stands alone as to these characteristics. It is Nature's contribution to power transmission needs. No other known substance is like it in wearing qualities. And no other belting material successfully replaces it.

There is no mystery about the quality of the leather in Graton & Knight Standardized Series Belts. It's in the *tanning*—an operation based on the *work to be done*. The yearly output of our tannery is nearly 300,000 hides. That makes *you* sure of uniform quality for any given specification. For there is a wide scope of selection from such a mountain of leather.

Graton & Knight Standardized Series Belts are made to give the longest possible service at the smallest possible cost. Those who use them say that they do. Length of service depends on the nature of the drive, of course. In some cases five months would finish the best belt ever made by man. But here is a case of hard work, day in and day out, with the ledger giving the answer to Graton & Knight quality.

Many of the best-belted plants ask us to specify the belting for every drive. Try the plan yourself. Then, when buying, call for "Graton & Knight——Brand or equal." This won't commit you to buying our belts. It will put your buying on the one basic consideration—the work to be done.

Write for our new book about Standardized Leather Belting

THE GRATON & KNIGHT MFG. CO., Worcester, Mass., U. S. A.

Oak Leather Tanners, Makers of Leather Belting, Lace Leather, Packings, and Specialties

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Dutch Bulbs
Order your Supply Now!

Advices from big growers in Holland indicate great scarcity of bulbs this coming season and enough cannot be grown to meet the demand. To insure getting your supply send us your order at once.

UNTIL JULY 1st NOT LATER our present low prices for the choicest varieties of bulbs grown by specialists in Holland will hold good.

By ordering from us now instead of waiting until Fall, you make a large saving, **get a superior quality of Bulbs not usually to be obtained at any price in this country,** and have a much larger list of varieties to select from.

Hyacinths, Tulips, Narcissi, Crocus, give, for a small outlay of time and money, an abundance of flowers in the house from December until Easter, and in the garden from earliest Spring until the middle of May.

Our orders are selected and packed in Holland and are shipped to our customers immediately upon their arrival in the best possible condition. They need not be paid for until after delivery, nor taken if not satisfactory.

A FEW PRICES	Per 100	Per 500
Fine Mixed Hyacinths	$6.00	$27.00
Fine Mixed Tulips	2.25	10.00
Fine Mixed Darwin Tulips	2.75	12.50
Double Daffodils	4.00	18.50
Narcissus Emperor	4.75	22.00
Narcissus Empress	4.50	21.00
Narcissus Golden Spur	4.25	20.00

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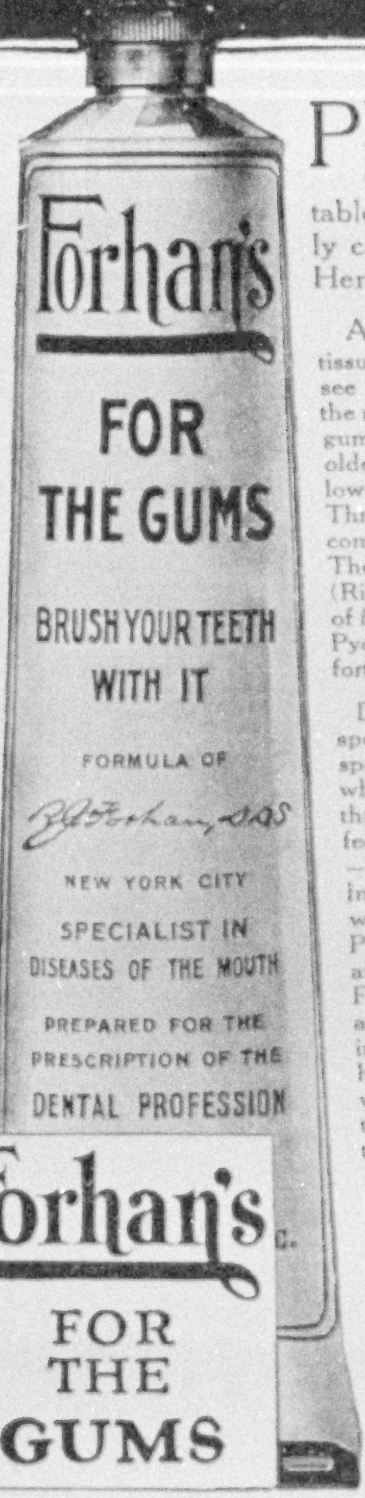
FREE BULB CATALOG

The most comprehensive published. Contains import price list giving prices on small and large quantities.

ELLIOTT NURSERY COMPANY
355 FOURTH AVE. PITTSBURGH, PA.

Beware of tender, inflamed gums


Forhan's
FOR THE GUMS
BRUSH YOUR TEETH WITH IT
FORMULA OF
NEW YORK CITY
SPECIALIST IN DISEASES OF THE MOUTH
PREPARED FOR THE PRESCRIPTION OF THE DENTAL PROFESSION

PYORRHEA, with a premature loss of teeth, is almost inevitable if you do not properly care for your gums. Here is the explanation:

As you age the body tissues naturally relax. You see this tissue-loosening in the neck. It goes on in your gums, too. As you grow older your gums shrink below the normal gum line. Through lack of care they become spongy and inflamed. Then you have Pyorrhea (Riggs' Disease). Four out of five people over forty have Pyorrhea. And many under forty, also.

Don't let a tender gum spot develop. These tender spots breed disease germs which enter the system through tiny openings—infecting the joints or tonsils—or causing other ailments. Immediately get Forhan's, which positively prevents Pyorrhea if used in time and used consistently. Forhan's tones the gums and hardens them. They in turn keep the teeth healthy. Brush your teeth with Forhan's. It cleans them scientifically—keeps them white and clean.

If gum-shrinkage has already set in, start using Forhan's and consult a dentist immediately for special treatment.

30c and 60c tubes
All Druggists

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Good-paying positions in the best studios of the country await men and women who prepare themselves now. For 25 years we have successfully taught

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Dodson Wren House
4 compartments, 28 inches high, 18 inches in diameter.

Dodson Bird Houses

Inviting Summer Homes for Our Native Birds

They are scientifically built by a bird-lover, who lives in a bird sanctuary and has devoted years of study to the song birds and their habits.

Mr. Dodson's close observation and nature study have taught him the small details which not only attract the birds to the homes he builds, but invite them to return season after season. These bird houses are not only an added attraction in themselves but are an assurance of an artistic and cheery environment.

Price **$5**

Order Now Let the houses lose their newness by weathering, blending into the natural surroundings. Free bird book sent on request, illustrating Dodson line and giving prices; also beautiful bird picture free.

Joseph H. Dodson, *Pres. Am. Audubon Ass.*
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Columbia Records

Photo by Lumiere

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Newest Columbia Star

In one splendid evening this young American girl of Italian parentage took her admitted place among the world-famous artists of the Metropolitan Opera Company. Rosa Ponselle makes records exclusively for Columbia. Her first four are:

La Forza Del Destino—La Vergine Degli Angeli (Verdi) Rosa Ponselle and Chorus	49558—$1.50
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Ask any Columbia Dealer to let you hear these wonderful records

COLUMBIA GRAPHOPHONE CO., NEW YORK

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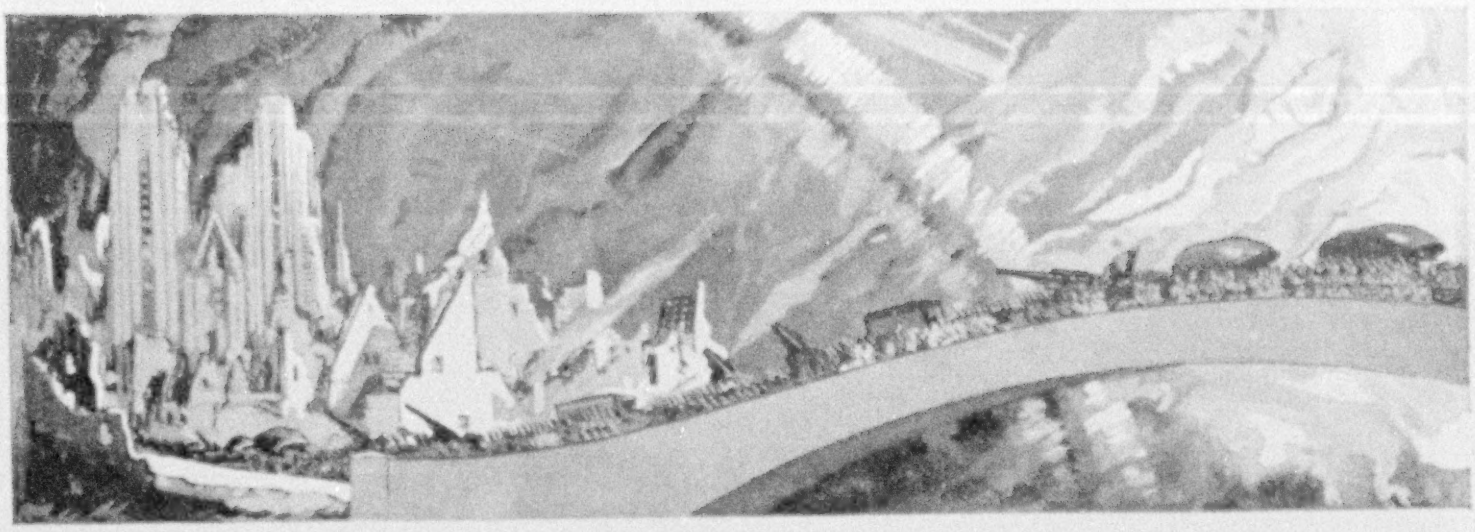

THE BUILDING MATERIAL DEALER
THEIR CONTRIBUTION

THE engines of war are silenced; the smoke of battle has cleared away. The period of reconstruction is here.

To those who fought, suffered, and won, all glory is due—now and always.

But let us not forget others who have done their share quietly, patiently, and unselfishly.

The walls of civilization were shattered, and through the breach came a devastating torrent of frightfulness. To stem this flood, into the gap the nation unselfishly threw its all.

The desired result was achieved; the fabric of civilization was again made whole. And all who helped gained sufficient reward in the knowledge of a great work well done.

All credit to whom credit is due. No one class suffered more acutely,

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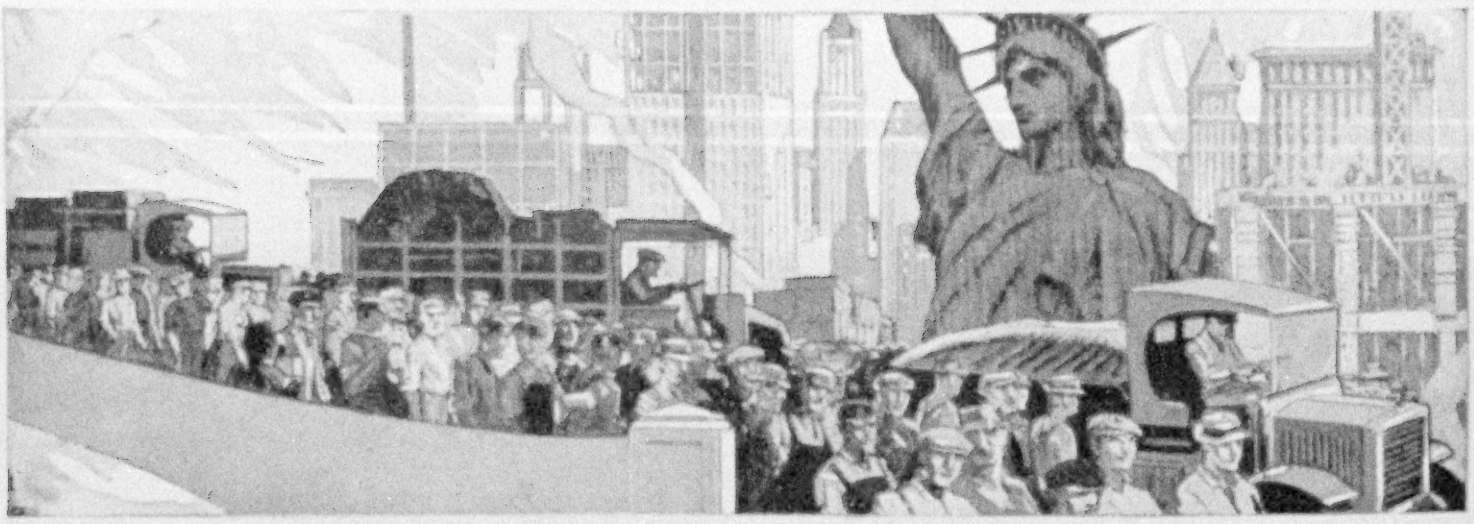

AND THE BUILDER TO PEACE AND PROSPERITY

more completely, and more uncomplainingly than the building material dealer, the builder, the architect, and the engineer.

The sound of hammer on nail, the rattle of hoisting machinery, the rumble of concrete mixers, were stilled. The nation's energy was needed elsewhere.

Our business lot has been thrown with those who have so unstintedly done their share toward the preservation of all we hold sacred.

It is our privilege at this time to acknowledge to them the country's sense of indebtedness and to express to them its thanks.

Now that the wheels of the world are again turning, the building material dealers and the builders will again take their rightful places in the community and share far more than ever in its development.

CEMENT COMPANY

The National Cement

LEHIGH CEMENT

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"Many Typewriters in One!"

"Just Turn the Knob"

Because the Type is INSTANTLY Inter-changeable

Many Styles and Many Languages

Put the Power of Emphasis Into Your Letters

Just as you do with the Spoken Word!

You can increase the effectiveness of your letters by putting the **power of emphasis** into your typewritten work—if you use the great **interchangeable-type** writing machine, the Multiplex.

No Other Typewriter Can Do This

You can **emphasize the important parts** by changing instantly from one style of type to another—as indicated here:

MULTIPLEX HAMMOND'S
Instantly changeable type
Many styles, many languages
Two types or languages always in the machine
Just Turn the Knob to change

Because of the **distinctive beauty** of Multiplex writing, you can put **character and individuality** into your letters. The impression of every letter is the same, and the alignment is perfect.

The Multiplex is **un-like** any other typewriter—there are **over 365 different type-sets, including all languages,** to select from.

The Multiplex has many **exclusive features** which place it in a class by itself.

It is revolutionizing typewriting. Let us tell you more about it.

Also—an Aluminum PORTABLE Model
For Traveling—for Home.
Weighs only about 11 pounds.
Full capacity. Ask for special folder.

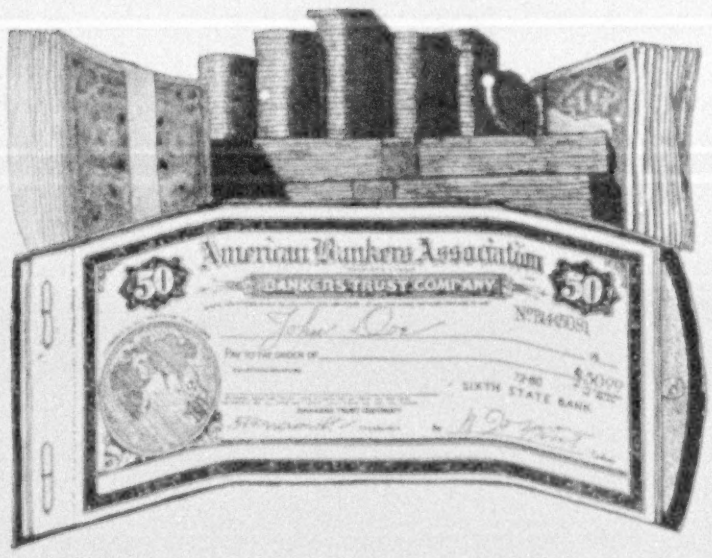
Send for FREE BOOKLET

It will show you how, with the Multiplex, you can write with the same **convincing force** that you use in speaking—an exclusive feature of the Multiplex.

And how, by "JUST TURNING THE KNOB," you can **drive home** with strength of accent the fullnes of **your argument.** We will also send you our pamphlet, **"The President and His Typewriter."**

Write your name, address, and occupation on the margin of this page NOW and mail to—

Hammond Typewriter Co.
637 East 69th St., New York City



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"A. B. A." Cheques are better than actual money for the traveler for several reasons: They are more convenient to carry—less bulky. They are *safer*, because no one can use them until you have countersigned them. Your countersignature on an "A. B. A." Cheque in the presence of the person accepting the cheque, is the only identification required.

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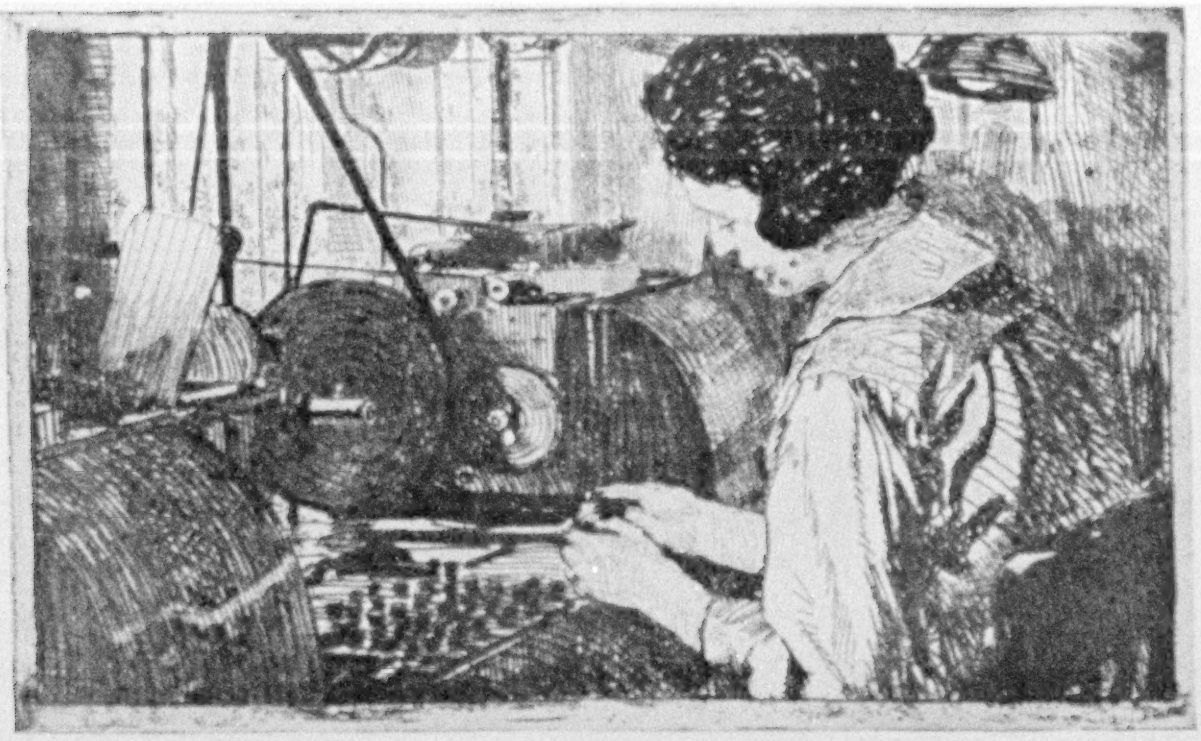
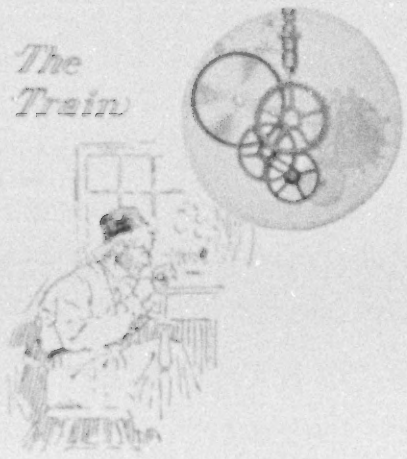
Get them at your bank, or write Bankers Trust Company, New York, for booklet and information as to where they may be had in your vicinity.

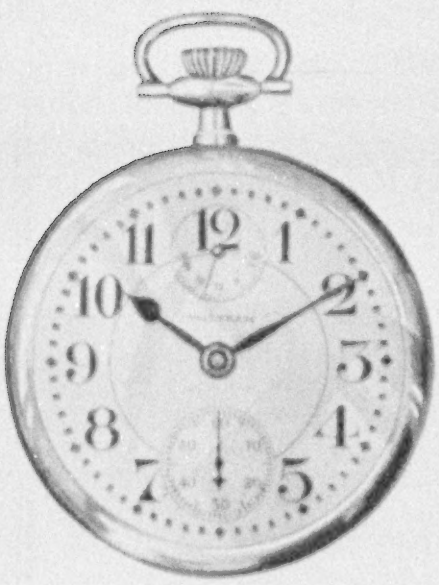
"A. B. A." American Bankers Association Cheques

WALTHAM THE SCIENTIFICALLY BUILT WATCH



AND THE FOREIGN BUILT WATCH





The Vanguard
The World's Finest Railroad Watch
23 and 19 jewels
$52 and up

Facts You Should Know Before Selecting a Watch

BETWEEN the two supporting plates of a Waltham watch, which together constitute a frame, is mounted a system of gearing, called a Time Train. The reader has learned that the motive power of the watch is derived from the mainspring. At one extremity of the train is a hardened and tempered steel barrel (another Waltham creation) which contains the mainspring. When the thumb and finger wind the mainspring, its stored energy is delivered to the next wheel in the train and from that to the next, and so on.

This train consists of four wheels and pinions. The center wheel is in the exact center of the watch, and directly connected through the cannon pinion (so called because it is shaped like a cannon) with the wheels that control the hour and minute hands; and through this center wheel the power of the mainspring is carried onward through the other wheels of the train to the escape wheel pinion, which we will illustrate in its proper place.

The train of a Waltham watch—each wheel, each pinion—is cut to the fraction of a human hair—mechanically perfect, interchangeable for the serial watches they are made for—standardized in perfection, in absolute exactness and quality, made by machines tuned to infinitesimal gauge-fit and untouched by human hands.

The "train" of the imported watch is made by the old hand process. It is not interchangeable, and it is of varying quality.

This vital part of the Waltham watch is another of those reasons why the horologists of great nations came to Waltham for time, and why your watch selection should be a Waltham.

Waltham placed America First in watchmaking.

WALTHAM

THE WORLD'S WATCH OVER TIME

XUM

Purity Cross

CHICKEN A LA KING

Plump breasts of chicken garnished with fresh mushrooms, and a dash of bright red pimentos — and over the whole, pure, rich cream sauce — all blended by our master chef — *that* is appetizing, delicious Purity Cross Chicken a la King!

Try it on Toast

Also — PURITY CROSS Welsh Rarebit, Creamed Spaghetti au Gratin, Creamed Finnan Haddie, Lobster Newburg, Chop Suey, and Corned Beef Hash. Sold by best grocers and delicatessens — in two size tins — ready for your instant convenience.

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If your dealer hasn't Purity Cross Delicacies — send us his name and $2.00 — and receive 5 regular size tins assorted *prepaid*.

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.....191

To the Secretary, National Geographic Society,
Sixteenth and M Streets Northwest, Washington, D. C.:

I nominate .....

Address .....

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for membership in the Society

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Name and Address of Nominating Member

AFTER a fire these nurses can only await orders. The hospital is being hurriedly emptied of patients. Some bed-ridden patients will die from exposure, lack of care and the temporary loss of prescriptions. These are conditions no city can imagine until it has been through them.

Quick plans now for the victims

THIS is what happens when a hospital burns. There are hurry calls for cots, quarters, medicines, supplies, more nurses, more doctors, vehicles, wheel chairs. Making lists of the rescued, gathering records and addresses. Meanwhile plans are slowly shaping in the minds of officials out of the panic and chaos.

All are emergency plans, temporary plans!

The whole sickening catastrophe could have been avoided by using just a little plain common-sense humanity beforehand. It would not have cost one-fiftieth the effort needed to care for the dead and living victims. Compassion, belated, is a mighty poor virtue.

Makeshift fire protective measures are the *most* that you will find in hundreds upon hundreds of hospitals. To the minds of fire protection experts, they all are a mere mockery of safety when the fire actually starts and spreads in the most horribly unexpected ways.

In twenty minutes a board of trustees can make complete plans to forestall this danger. They can vote "against any consideration whatever of suggestions or measures of safety, until a system of automatic sprinklers is decided upon which will *prevent* fires; put out any fire, anywhere, any time, before it can endanger health or lives."

Read—*"Fire Tragedies and Their Remedy"*

Any individual, trustee or official will find in "Fire Tragedies and Their Remedy" the unvarnished truth and a path of imperative social service. Write for it today. Address General Fire Extinguisher Company, 293 West Exchange St., Providence, R. I.

Take These Plain Facts

Some five billion dollars of business property has been protected from fire by automatic sprinklers.

State Industrial Commissions are guarding the lives of factory employees by requiring this same unfailing protection in business property.

The United States Government insisted on war industries being so protected.

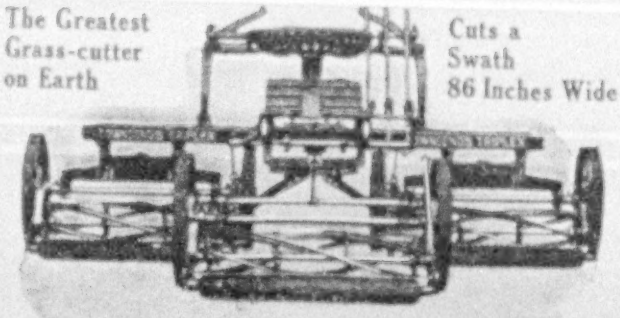
GRINNELL

AUTOMATIC SPRINKLER SYSTEM

When the fire starts the water starts

TOWNSEND'S TRIPLEX

The Greatest Grass-cutter on Earth



Cuts a Swath 86 Inches Wide

Floats Over the Uneven Ground as a Ship Rides the Waves

One mower may be climbing a knoll, the second skimming a level, while the third pares a hollow. Drawn by one horse and operated by one man, the TRIPLEX will mow more lawn in a day than the best motor mower ever made; cut it better and at a fraction of the cost.

Drawn by one horse and operated by one man, it will mow more lawn in a day than any three ordinary horse-drawn mowers with three horses and three men.

Does not smash the grass to earth and plaster it in the mud in springtime, neither does it crush the life out of the grass between hot rollers and hard, hot ground in summer, as does the motor mower.

The public is warned not to purchase mowers infringing the Townsend Patent, No. 1,209,519, December 19th, 1916.

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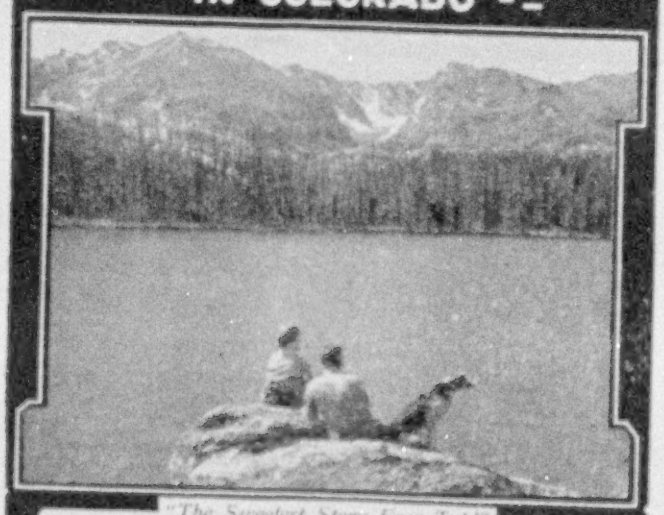

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NATIONAL GEOGRAPHIC MAGAZINE

WASHINGTON, D. C

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MOTOR TRUCKS

"BY their fruits ye shall know them" applies to motor trucks as to most other mundane things.

Denby Motor Truck Company

Detroit Michigan

DON'T BE ASHAMED
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Your garbage can should be just as unnoticed and just as sanitary as the rain spouts on your house. Witt's meets these requirements. It won't rust and won't dent. Made of heavy galvanized, corrugated steel—29 times stronger than plain steel. It outlasts two ordinary cans. Witt's lid fits air-tight. Keeps odors in; keeps dogs, rats, flies out. Buy Witt's for your home. It saves you money. Write for Booklet and name of nearest Witt dealer.

THE WITT CORNICE CO.
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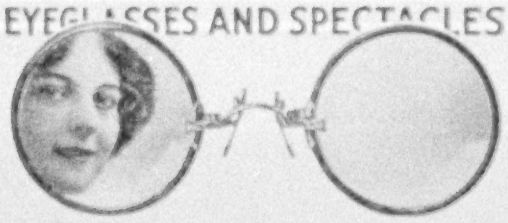
EYEGLASSES AND SPECTACLES



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Foreword by President Wilson. Preface by Admiral Gleaves, U. S. N.

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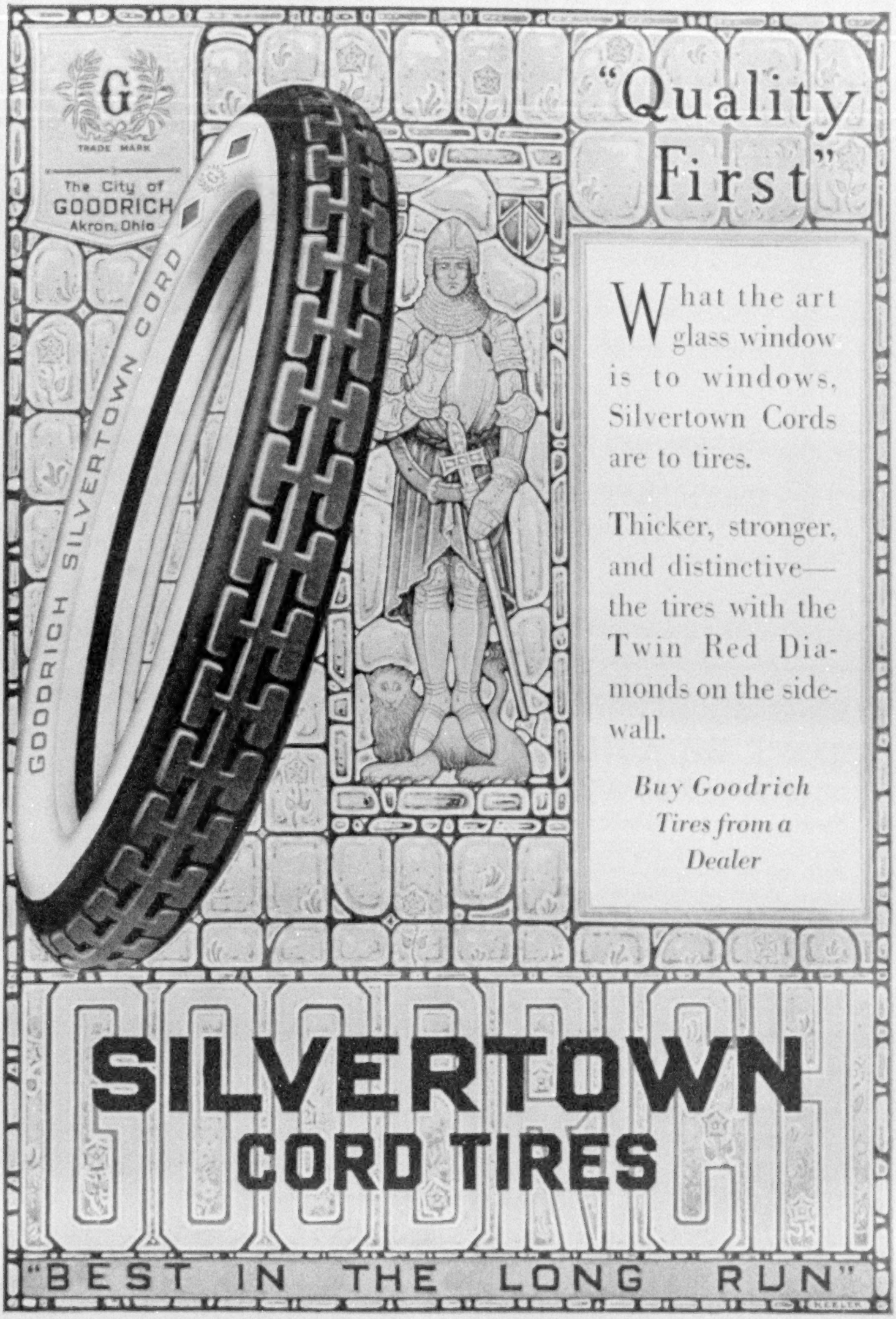
Price, $2.00 per copy, postpaid; procurable from the Navy Relief Society, Washington, D. C. Net proceeds for relief of widows and orphans of enlisted men of the Navy.



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If it hasn't this Red Woven Label

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It isn't B.V.D. *Underwear*

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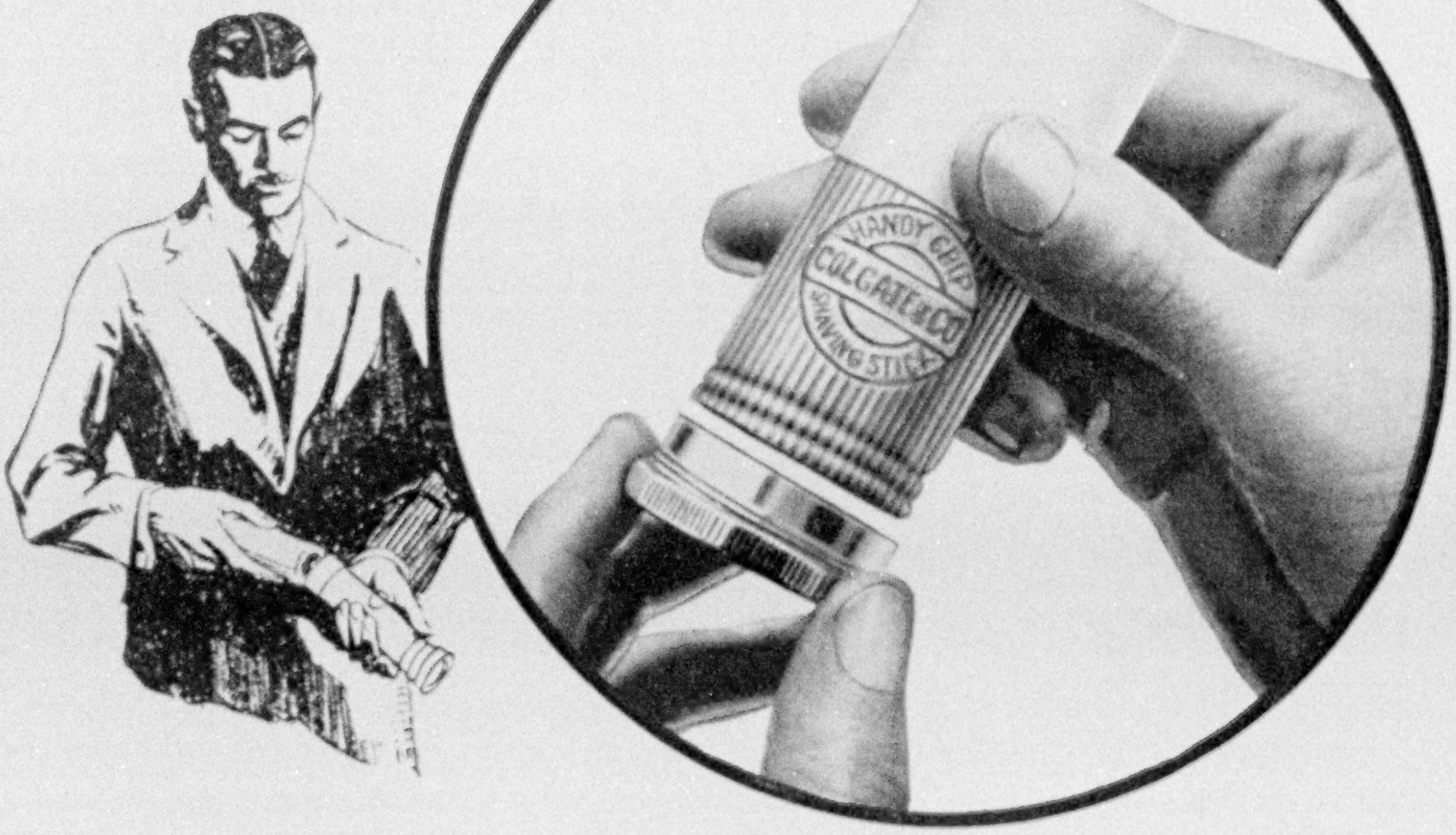
The only Refill Shaving Stick



"like putting a new battery in a flash-light"

If you use Colgate's Handy Grip Shaving Stick you can renew the soap as easily as you replace the worn-out battery in a flash-light. It is made to be used that way—for convenience and economy.

You will notice that the "socket" of the Handy Grip is threaded. When your soap is nearly gone, get a Colgate "Refill" Stick, which costs less than a complete Grip and is threaded to fit the socket. Unscrew the last of the soap (using a knife-blade like a screw-driver) and screw in the "Refill." Then add still another economy by sticking the unscrewed stub on the end of the "Refill"—there are **50** cool, comfortable Colgate shaves ***saved*** that way.

The Shaving Stick is the economical way to make a satisfactory lather. We can give you impartial advice because we make Shaving Sticks, Powder and Cream.

Wet the old stub and press it on the "Refill"—it sticks. The "Refill" saves you the cost of a new metal box.

COLGATE & CO. Established 1806 NEW YORK